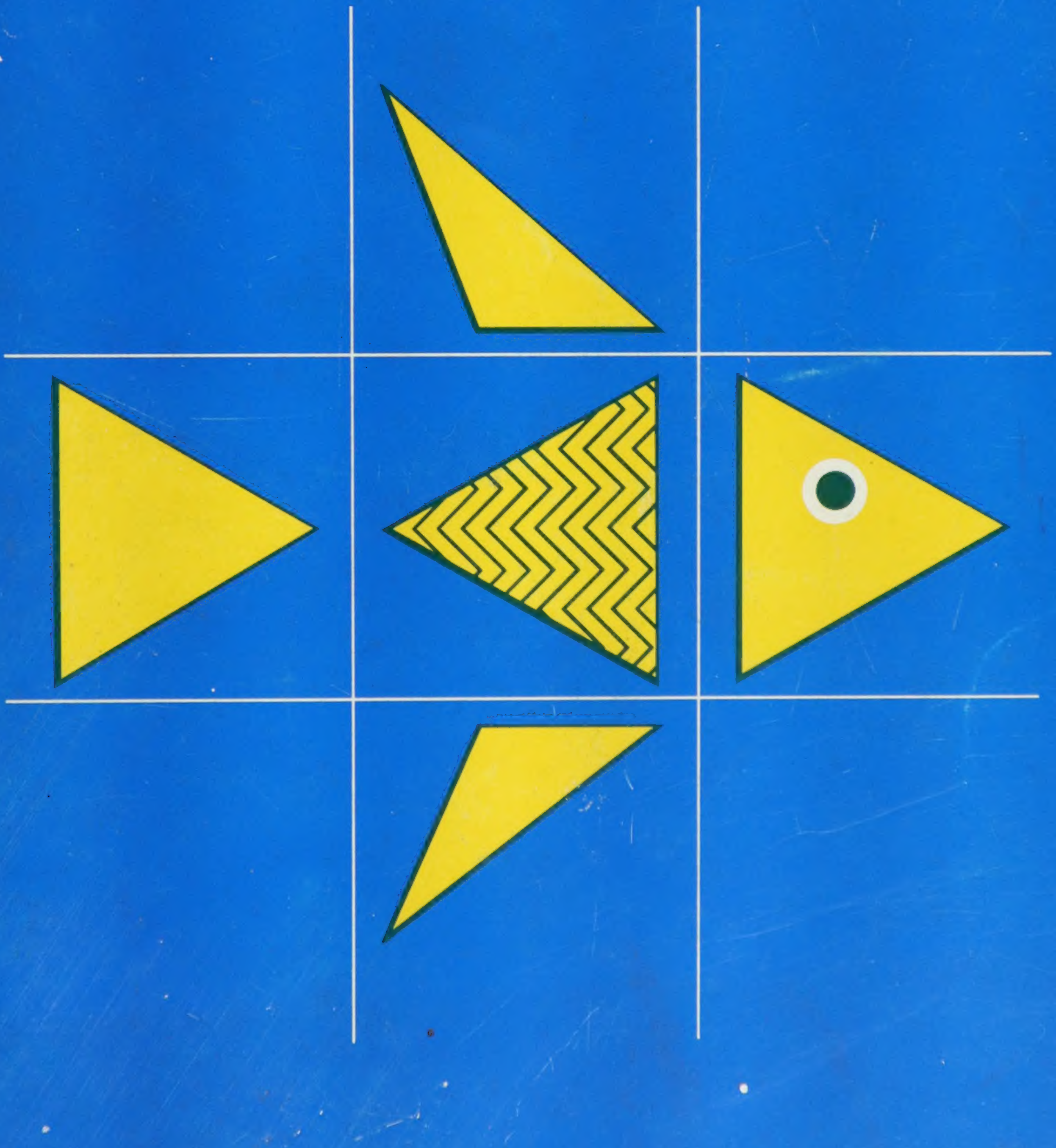
CONFERENCE PROCEEDINGS

# Handling, Processing and Marketing of Tropical Fish



TROPICAL PRODUCTS INSTITUTE

Tropical Products Institute

# Proceedings of the Conference on the handling, processing and marketing of tropical fish

Held in London
5th – 9th July 1976

Ministry of Overseas Development

Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
1977

Due to the large numbers of papers included in the Conference, it was decided that, for each session, selected papers would be presented by the authors and the remainder summarized by the moderator. The Conference allocated discussion periods for the presentation papers and moderated papers and, after the moderators review, individual authors were given an opportunity to speak on their paper. Discussion periods were very active; and, for some sessions, extra time was allowed. All discussions were recorded and summarized by the rapporteurs.

Since all the papers are published in full, comments by the authors of moderated papers are included only if additional information was supplied. In order to limit the size of these proceedings, summarises of the discussion periods are given; it has not been possible to name all who contributed to the discussions.

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# Contents

Page

Acknowledgements .. .. .. 3

Programme Committee .. .. .. 9

Introductory remarks by the Chairman, P. C. Spensley .. .. .. 11

Opening address by F. Judd, MP, Ministry of Overseas Development .. .. .. 13

**Session 1: Introduction**

Fish resources in the tropics, by S. Chikuni .. .. .. 17

Technology in fisheries development in the tropics, by N. R. Jones and J. G. Disney .. .. .. 27

Discussion .. .. .. 33

**Session 2: Microbiology and quality control**

Fish inspection and quality control in the United Kingdom, by D. T. Jones .. .. .. 37

Organization of fish inspection programmes in developing countries, by R. Garm and L. Limpus .. .. .. 45

The bacteriology of fresh and spoiling fish and the biochemical changes induced by bacterial action, by J. M. Shewan .. .. .. 51

Papers reviewed by the moderator

La inspección y el control de calidad del pescado en el Perú, por C. Alegre S. .. .. .. 67

Fish inspection and quality control in Brazil, by C. A. M. Lima dos Santos .. .. .. 73

Keeping quality and freshness determination of *Sardinella aurita,* by A. Herzberg, Rachel Pasteur and Miriam Rosenblatt .. .. .. 83

Some technological characteristics of hake from South American waters, by H. H. Huss and I. Asenjo .. .. 89

A new method to classify fishery products by microbial risk, by E. S. Garrett, G. J. Haines Jr., J. R. Brooker, R. W. Hamilton, T. J. Billy, P. K. Stocks and C. A. M. Lima dos Santos .. .. .. 95

Discussion .. .. .. 101

## Session 3: Fresh fish

Fresh fish: the problems in small-scale fisheries, by H. Lisac .. 105

The handling and transportation of fish in Malaysia, by A. Kamari, A. Z. Idrus and Zahara Merican .. 115

Papers reviewed by the moderator

Marketing

Fish marketing conditions of Ashar (Basrah, Iraq) fish market, by S. K. Al-Nasiri and K. P. Sharma .. 121

Development possibilities for wholesaling and retailing fish in the Caribbean, by J. F. Arrundale .. 127

The fresh fish trade in Indonesia, by S. Ilyas .. 145

Analytical studies

Relationship of meat yield to round weight of milkfish (*Chanos chanos,* Forskal), by Patricia T. Arroyo, K. M. Apolinario, T. D. Santos, L. G. de la Cruz, A. Abante and E. A. Santos .. 151

Biochemical studies on some commercially important fish of Shatt Al-Arab and the Gulf, by K. Das, S. K. Al-Nasiri, N. A. Shukri and K. P. Sharma .. 157

Mercury content in the main marine species in Uruguay, by S. Mattos A. and E. Torrejon S. .. 163

Handling and distribution

Handling fish in Ghana, by Lydia A. Bonsu .. 167

A new system for boxing iced fish in the tropics, by F. Anthonsen, Thyra Bjergskov and P. Hansen .. 173

Handling and transportation of fish in India, by P. A. Perigreen and M. R. Nair .. 177

Note on the distribution of live fish in Thailand, by Bung-Orn Saisithi .. 181

Discussion .. 183

## Session 4: Frozen fish

Frozen fish marketing in developing countries, by W. Krone .. 189

The exportation of frozen fish from a developing small-scale fishery, by S. Vidot and C. Ratcliffe .. 195

Papers reviewed by the moderator

The UK market for frozen fish from tropical sources, by J. D. Walton .. 201

Frozen fish marketing in Nigeria, by S. O. Talabi and C. F. Makanjuola .. 205

Marketing of frozen fish in India, by K. K. P. Menon .. 215

Discussion .. 219

## Session 5: Fish meal, fish silage and new products

Fishmeal manufacture in the tropics, by S. M. Barlow .. 223

Recent developments in fish silage, by J. G. Disney, I. N. Tatterson and June Olley .. 231

Fish product development in India, by G. K. Kuriyan .. 241

Papers reviewed by the moderator

Minced fish as an ingredient in food combinations, by M. A. Steinberg, J. Spinelli and D. Miyauchi . . . . 245

Development of novel fish products in the Caribbean area, by L. Herborg . . . . . . . . . . . . . . 249

Fish cheese: the preservation of minced fish by fermentation, by L. Herborg and S. Johansen . . . . 253

Study on the utilization of *Engraulis anchoita* for the preparation of anchovies, by S. Mattos A., E. Torrejon S., L. Gus P. and J. Rodriguez S. . . . . . . . . . . . . . . . . . . . . . . . . 257

Acceptability testing of FPC Type B in selected developing areas, by Maria A. Tagle, S. Valand and D. G. James . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 261

Fish protein concentrate from trash fish, by A. Vasantha Shenoy, M. P. Kutty Ayyappan and K. Gopakumar . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 269

Comparative study of fish ensilage prepared by microbial fermentation and formic acid ensilage, by M. A. James, K. M. Iyer and M. R. Nair . . . . . . . . . . . . . . . . . . . . . . . . 273

Low salt fermentation method for conserving trash fish waste under SE Asian conditions, by W. R. Stanton and Quee Lan Yeoh . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 277

Le nuoc-mam: une providence pour les pays en voie de développement, par A. Faubeau . . . . . . 283

The utilization of by-catch in shrimp fisheries, by W. H. L. Allsopp . . . . . . . . . . . . . . 287

A note on salt minced fish, by E. G. Bligh . . . . . . . . . . . . . . . . . . . . . . . . 291

Discussion . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 293

**Session 6: Canned and other processed fish**

Fish processing and marketing in the tropics: restrictions to development, by D. G. James . . . . . . 299

Prospects for canning fish and shellfish in India, by K. K. Balachandran and M. R. Nair . . . . . . . . 303

Papers reviewed by the moderator

The control of insect infestation of fish during processing and storage in the tropics, by D. L. Proctor . . 307

Some protective measures against insect infestation of dried fish in Africa, by E. Kordyl . . . . . . 313

Traditional processing in the Philippines, by F. R. Gonzales . . . . . . . . . . . . . . . . . . 315

The influence of traditional handling methods on the quality of processed fish in Nigeria, by F. N. C. Osuji . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 319

Dried fish production in Sri Lanka, by K. Sachithananthan . . . . . . . . . . . . . . . . . . 323

Conservation par fumage de quelques poissons Guyanais de lagune (Siluridés), par H. Durand . . . . . . 327

Design of a commercial dehydration plant and economics of production, by P. K. Chakraborty . . . . 331

The canning of fish in the tropics, by V. Perovic . . . . . . . . . . . . . . . . . . . . . . 337

Fish handling, processing and marketing in the Lake Chad Basin (north west shores), by N. I. Azeza . . 349

The mycoflora associated with dry salted tropical fish, by Sarah Phillips and Ann Wallbridge . . . . 353

Discussion . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 357

**Session 7: Shellfish**

Historic and developmental problems in the Guianas and Caribbean shrimp fishing industry, by F. A. Peterkin . . 363

Export of shrimp from India, by B. L. Amla and D. P. Sen . . . . . . . . . . . . . . . . . . 367

The European market for tropical prawns, by N. W. Young .. 373

Bacteriology of shellfish with reference to international trade, by D. C. Cann .. 377

Papers reviewed by the moderator

Practical problems associated with the export of prawns and fishery products from tropical countries, by D. F. Townsend .. 395

The frozen prawn industry of Malaysia, by Zahara Merican, A. Z. Idrus and A. Kamari .. 399

Biochemistry and physiology of shrimp: effect on use as food, by B. F. Cobb III .. 405

Technological aspects of preservation and processing of edible shellfish, by C. George and M. R. Nair .. 413

Chilling of langostinos (*Pleuroncodes monodon*): some observations on organoleptic quality and yield, by H. H. Huss and I. Asenjo .. 417

Discussion .. 421

**Session 8: Fisheries development**

Les problèmes rencontrés dans la modernisation de la pêche traditionelle dans les pays en développement, par R. A. Moal et Y. Lagoin .. 425

Fisheries development in Malawi: commercial trawling, by A. J. Mathotho and J. F. Rogers .. 433

Papers reviewed by the moderator

The role of the fisheries extension service in rural development, by R. C. Cole .. 439

Small-scale fisheries development, by D. G. James .. 447

Socio-economic aspects of fisheries development, by Rowena M. Lawson .. 455

The economics of fish processing, by J. R. Shaw .. 461

Developments in fish utilization, by D. G. James and W. Krone .. 467

Village level processing in Zambia and the potential for improvement, by I. J. Clucas and S. Chamasonde .. 473

A tropical African artisanal lake fishery: Lake Rugwero, Rwanda, by I. G. Dunn .. 479

Discussion .. 485

**Session 9: Close**

Commentary on the Conference, by N. R. Jones .. 491

Discussion .. 497

Concluding remarks .. 499

**List of Registered Delegates** .. 501

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| | |
|---|---|
| **J. D. Walton** | International Fish Co Ltd,<br>14 West Smithfield,<br>London EC1A 9JP |
| **J. J. Waterman** | Torry Research Station,<br>PO Box 31, Aberdeen AB9 8DG |
| **G. R. Watkin** | Fishmongers Company,<br>Fishmongers Hall, London EC4R 9EL |
| **C. E. P. Watson** | White Fish Authority,<br>10 Young Street,<br>Edinburgh EH2 4JQ |

| | |
|---|---|
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# Introductory remarks

**by the Chairman, P. C. Spensley**
Director, Tropical Products Institute

Mr Judd, Ladies and Gentlemen

It gives me great pleasure on behalf of my colleagues at the Tropical Products Institute and myself to welcome you all to this International Conference on the Handling, Processing and Marketing of Tropical Fish. We are delighted to see you all and I would like to offer a special welcome to the large number of delegates who have travelled from overseas to be with us. It is particularly gratifying to have such a high number of participants from the developing countries and altogether more than 50 countries are represented here today.

The organization of international conferences dealing with particular commodities is a regular feature of the Institute's programme. Previous meetings have dealt with such differing commodities as animal feeds, essential oils, spices and fruits but they had, in common with the Conference starting today, a common objective. The intention is to bring together the producer from the less developed parts of the world, with his problem, and the user in the more developed countries, with his particular requirements and difficulties. Unlike previous conferences, however, this one deals with a commodity which is not only important in international trade but is also vital to the food economy of the developing world. In this sense then the theme of this Conference will differ from previous ones but there is no doubt that the international trade in fish commodities, as well as the need to meet the local demand for animal protein, are both important to many developing countries.

I believe that this is the first international conference dealing solely with the post-harvest aspects of fisheries development in the tropics. With so many participants from the tropics and the presence of representatives from many bi-lateral and multi-lateral aid agencies, we hope that this meeting will provide a forum for a fruitful exchange of information and ideas on the problems encountered in the developing fisheries of the world. Many developing fisheries experience similar problems and discussions between workers from these countries can only be beneficial in seeking solutions to these mutual problems. These problems are perhaps more serious in the artisanal or small-scale fisheries and it is particularly appropriate that the Conference will pay special attention to this sector.

From the programme you will notice that we have a very full schedule before us. There are, I believe, 71 papers in all, largely from developing countries. This response was most gratifying and I would like to thank the Programme Committee for preparing such an excellent programme.

I would now like to introduce Mr Frank Judd who was recently appointed Parliamentary Under-Secretary to the Minister of Overseas Development. Mr Judd is a former member of the Parliamentary Select Committee on Overseas Aid and I know he has taken a close interest in overseas development for many years. It is therefore with the greatest pleasure that I welcome him and ask him if he would honour us with an address to open this Conference.

# Opening Address

## by Mr Frank Judd, MP

Parliamentary Under Secretary, Ministry of Overseas Development

Mr Chairman, Ladies and Gentlemen

Firstly, I would like to welcome everyone to this Conference, particularly the many delegates from overseas. I hope that you will enjoy your visit to London. Some of you will be travelling later to Humberside and Scotland with the Post Conference Tour of the fishing industry and I am sure that you will appreciate the opportunity to see something of Britain.

This Conference is one of a biennial series organized by the Tropical Products Institute. The Institute is one of the Scientific Units of the Ministry of Overseas Development and it has a long and distinguished history of work on tropical food products, going back more than eighty years. It has wide commodity interests and its earlier meetings have helped in the development of several fields.

This year, as Dr Spensley has said, the Institute has convened the first international conference on the handling, processing of tropical fish. You have come together, if I may say so, with a nice sense of timing. Pressures on fisheries resources have been increasing, as on world food supplies generally. Margins of food supply have become slender even in the more affluent countries. In those countries most in need, their disappearance has had serious consequences. The twin aims of the conference are to consider how tropical fish may best be used to human advantage, and how the industry, particularly the producer, can be encouraged in its efforts through benefits arising out of improved technology and marketing.

By way of background to the scale of the development, we should note that about a third of the world's catch of 70 million tonnes (1974) is harvested from tropical waters.

In 1973 (the latest figures available) the catch taken by developing countries was valued at US $ 1,110 millions. To this, the post-harvest system subsequent to landing, added a value of the order of 20% within the countries of origin. In addition to the traditional markets for tunas and fish meal, considerable export opportunities have developed for frozen tropical shrimp. Possibilities exist also for the expansion of other sectors of the industry. This conference is considering therefore a substantial industry, important both as a source of food and a source of foreign exchange for countries fortunate enough to possess a resource.

During the course of the Conference, you will be addressing yourselves to a number of difficult technical and marketing problems. I am particularly pleased to hear that you will be giving special attention to the problems of the artisanal fisherman. The Ministry of Overseas Development awards the highest priority in its programmes, to collaboration with developing countries in rural development projects and is of course interested in fisheries development in this context. Solutions are not easy, the problems being as much, if not more, sociological, infrastructural and educational, as technical. The Tropical Products Institute has been concentrating its programme in this area of development, in keeping with the Ministry's policy, and I know that the staff of the Institute has been looking forward to a fruitful discussion here.

Three weeks ago in Rome, in addressing the World Food Council, I felt it right to remind my fellow Ministers that when we concern ourselves with wheat, or rice, or fish; when we discuss fertiliser or protein, or any of these things, we must constantly remind ourselves that we are ultimately talking about people; millions of under-fed, under-nourished men, women and children. We should all therefore be fired with a strong sense of urgency when we meet to talk about any aspect of world food.

In this connection I reminded the Council that food was not only land produced. I said: 'We must not overlook that important protein source of the seas and the oceans – these already provide some 14% of world consumption of animal protein. Here is one important area where perhaps the developing and industrialized countries alike could benefit from greater effort in the provision of research, technical assistance and capital aid. We need in parallel to maximize the efficiency of resources already being tapped whilst at the same time increasing the capacity of developing countries to tap new resources' – I believe there is still a great deal to achieve in this direction.

Fish is one of the most nutritious of foods. It contributes a considerable proportion of the protein diet of many poorer populations, particularly those of SE Asia, and the food potential of the resource has been appreciated increasingly in other countries. India, for instance, has a considerable programme of fisheries development planned to assist in the country's protein nutrition.

Unfortunately, fish is among the most perishable of foods. Even the relatively stable traditional products of the tropics can be lost all too easily. Losses in traditional processing are commonly of the order of 25%. The application of technologies that are optimal to the conditions applying in individual developing countries can go a long way towards eliminating such wastage.

The introduction of new technologies again appropriate to local conditions and the demands of the market, offers prospects for the further reduction of wastage and for improving the return to the fisherman.

A conference such as this, which brings together delegates from so many developing countries, and specialists from the international agencies and from countries with aid programmes, offers a unique opportunity to put forward ideas for furthering the development of tropical fisheries technology and marketing. I wish you every success.

# Session 1

## Introduction

**Monday 5th July**
**Morning**

Chairman
P. C. Spensley
Tropical Products Institute
UK

Rapporteur
J. F. Rogers
Tropical Products Institute
UK

# Fish resources in the tropics

**S. Chikuni***
Department of Fisheries, FAO, Rome

## Summary

Fish production from tropical waters has increased in recent years reaching about 18 million tonnes in 1973 and forming 27 per cent of the world's total catch. The production is composed of 11 million tonnes of marine fish (80 per cent) and 4 million tonnes of freshwater fish (20 per cent).

Coastal and off-shore resources are greatest in the Western Central Pacific followed by the Indian Ocean. In these two regions potential is high and exploitation light or moderate, although some stocks are fully exploited. Atlantic Ocean resources are moderately exploited with some stocks heavily exploited. Catch and potential in the East and Central Pacific are relatively small but there is still exploitable potential. Shrimps and cephalopods seem to have been fully exploited in all coastal regions.

Among the oceanic resources, the larger tunas are considered to have been fully exploited already in all regions. Skipjack catches can be increased from four to ten times. The quantity is not so great compared with that of coastal resources, but it may benefit the fishery in terms of value.

It is predicted that production from tropical waters will increase for some years. Increases from pelagic stocks in the Eastern Central Atlantic and Indian Ocean, pelagic and demersal stocks in the Western Central Pacific, and from skipjack stocks in all regions can be expected.

## Résumé

La production de poisson dans les eaux tropicales a augmenté au cours des récentes années atteignant environ 18 millions de tonnes en 1973 et représentant 27 pour cent du produit total mondial de la pêche. Cette production est constituée de 11 millions de tonnes de poisson de mer (80 pour cent) et de 4 millions de tonnes de poisson d'eau douce (20 pour cent).

Les ressources côtières et de haute mer les plus importantes se trouvent dans le Centre Ouest du Pacifique précédant celles de l'Océan Indien. Dans ces deux régions, les ressources potentielles sont élevées et leur exploitation faible ou modérée bien que certaines de leurs possibilités soient complètement exploitées. Les ressources de l'Océan Atlantique sont modérément exploitées avec quelques possibilités fortement exploitées. Le produit effectif et potentiel de la pêche dans la partie Est et Centrale du Pacifique est relativement faible mais il existe encore un potentiel exploitable. Les crevettes et les céphalopodes semblent avoir été complètement exploités dans toutes les régions côtières.

Parmi les ressources de l'océan, on considère que les thons de grande taille ont déjà été complètement exploités en toutes régions. Les prises de bonites à ventre rayé peuvent être augmentées de quatre à dix fois. Elles ne sont pas aussi abondantes que celles de la pêche côtière mais elles peuvent être rentables.

On prévoit que la production de la pêche dans les eaux tropicales augmentera pendant quelques années. On peut s'attendre à des augmentations des ressources pélagiques dans le Centre Est de l'Océan Atlantique et dans l'Océan Indien, des ressources pélagiques et de surface dans le Centre Ouest du Pacifique et des ressources de bonites à ventre rayé dans toutes les régions.

## Resumen

La producción de pescado en las aguas tropicales ha aumentado en los últimos años, alcanzando los 18 milliones de toneladas métricas en 1973 que constituyen el 27 por ciento de la pesca total mundial. La producción se compone de 11 milliones de toneladas de pescado marino. (80 por ciento) y 4 milliones de toneladas de pescado de agua dulce (20 por ciento).

Los más importantes recursos pesqueros, costeros y de alta mar, están en el Pacífico Centro-Occidental, seguido del Océano Indico. En estas dos regiones el potencial es grande y la explotación pequeña o moderada, aunque algunos bancos están completamente explotados. Los recursos del Océano Atlántico están moderadamente explotados, con algunos bancos que lo están excesivamente. Las capturas y el potencial del Pacífico Central y Oriental son relativamente pequeños, pero existe

---

*Paper presented by D. G. James, Department of Fisheries, FAO, Rome todavía un potencial explotable. Las camarones los cefalópodos parecen haber sido completamente explotados en todas las zonas costeras.

Entre los recursos oceánicos, los atunes de mayor tamaño se consideran ya íntegramente explotados en todas las regiones. Las capturas de bonito de altura (listado) pueden aumentarse de cuatro a diez veces. La cantidad no es grande comparada con la de los recursos costeros, pero puede representar beneficios económicos para la industria pesquera.

Se ha pronosticado que la producción de las aguas tropicales aumentará durante algunos años. Se esperan incrementos de los bancos pelágicos en el Atlántico Centro Oriental y el Océano Indico, de los pelágicos y de aguas profundas en el Pacífico Centro Occidental y del bonito de altura (listado) en todas las regiones.

## Introduction

Fish production from tropical waters has increased rapidly in recent years and it now has become an important segment of world fish production. It formed more than one fourth of the total world production in 1973. A rational exploitation of this important resource has been difficult to achieve because of the large variety of species and their distribution; the many countries involved and their differing socio-economic structures; and insufficient catch data for a detailed analysis of utilization.

Due to these circumstances, it is at the moment very difficult to investigate accurately the status of resources in tropical waters and to compile analyses species by species. In this paper the author reviews, rather roughly, the annual change in the catch from tropical waters, compares the latest figures of catch with the estimated exploitable potential and discusses the possibility, of future production from tropical waters.

## Data and methods

All the catch statistics for 1965–1973, used in this paper, were taken from the FAO Yearbook of Fishery Statistics (FAO, 1974a). The statistics were rearranged into regions based on the FAO fishing areas, namely:

Western Central Atlantic (FAO area 31) and Southwest Atlantic (FAO area 41) were combined as Tropical Western Atlantic.

Eastern Central Atlantic (FAO area 34) and Southeast Atlantic (FAO area 47) formed the Tropical Eastern Atlantic.

Western Indian Ocean (FAO area 51) and Eastern Indian Ocean (FAO area 57) formed the Tropical Indian Ocean.

Western Central Pacific (FAO area 71) formed the Tropical Western Pacific.

Eastern Central Pacific (FAO area 77) formed the Tropical Eastern Pacific.

Some retabulations and modifications of the statistics have been made to show the production from tropical waters more precisely. For example, the coastal catches by countries located outside the tropical zone, such as USA, South Africa and Argentina, were subtracted from the figures. The Peruvian anchoveta catch was excluded because it was considered to be a special case and the variation of the catch would unduly influence the apparent change of the total figures in the region. The catch statistics of Australia for the Indian Ocean area were also excluded because the majority of the catch is taken from waters outside the tropics.

Of course there are still some biases even in the revised figures due to the discrepancy between the geographical boundaries of the tropical zone and those of the statistical areas, but the author thinks that the modified statistics are the best available data for a world-wide review. The estimated exploitable potential of resources were cited from FAO's contributions (FAO, 1971, 1973 and 1974).

## Annual change in the catch

The total catch from tropical waters has increased rapidly from 10 million tonnes in 1965 to 18 million tonnes in 1973 (Table 1 and Figure 1). The proportion of the tropical catch to the world total catch has increased from 20 per cent in 1965 to 27 per cent in 1973. The rapid increase of the catch from the tropics (by 70 per cent from 1965 to 1973) was mainly due to increased marine catches. The catch from inland waters has also increased in these years, but the quantity and the rate of increase are not so large as the marine figures.

**Figure 1**
**Total catch from tropical waters, 1965–1973**

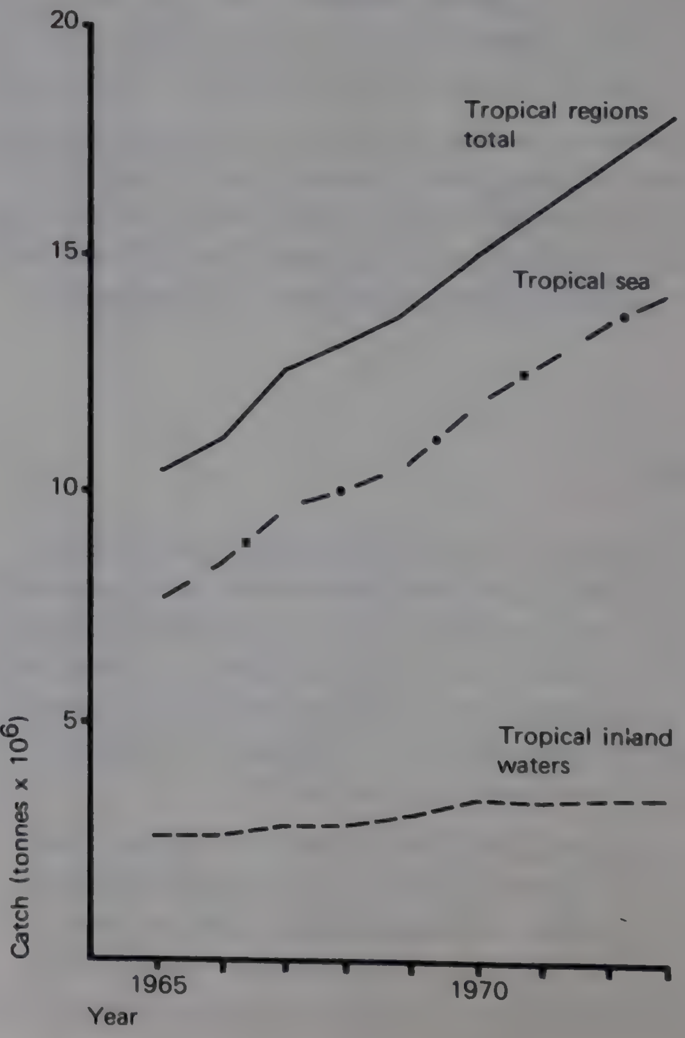


TABLE 1. *Total world catch and total catch from tropical waters (tonnes x $10^3$)*

| | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|---|---|---|---|
| Total world catch | 53,200.0 | 57,300.0 | 60,400.0 | 63,900.0 | 62,700.0 | 70,000.0 | 70,200.0 | 65,500.0 | 65,700.0 |
| Total tropical catch | 10,402.4 | 11,302.0 | 12,580.8 | 13,280.8 | 13,932.5 | 15,348.1 | 16,142.7 | 17,114.2 | 17,952.1 |
| Marine | 7,748.0 | 8,607.6 | 9,729.8 | 10,272.9 | 10,738.4 | 11,993.9 | 12,724.0 | 13,598.0 | 14,304.1 |
| Inland waters | 2,654.4 | 2,694.4 | 2,850.7 | 3,007.9 | 3,194.1 | 3,354.2 | 3,418.7 | 3,516.2 | 3,648.0 |

TABLE 2. *Annual catch from the tropical waters by region and fish group (tonnes x $10^3$)*

| *Region and fish group* | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|---|---|---|---|
| *Tropical Atlantic, Western* | 684.2 | 775.4 | 1,422.0 | 1,017.2 | 885.2 | 1,256.9 | 946.8 | 1,038.1 | 1,003.0 |
| Coastal and off-shore fish | 636.3 | 744.7 | 1,397.4 | 993.1 | 851.3 | 1,225.6 | 917.9 | 1,026.2 | 975.0 |
| Oceanic fish, Total | 47.9 | 30.7 | 24.6 | 24.1 | 33.9 | 31.3 | 28.9 | 11.9 | 28.0 |
| Large tunas | 46.4 | 29.0 | 21.9 | 21.5 | 32.2 | 29.3 | 26.4 | 9.4 | 25.3 |
| Skipjack | 1.5 | 1.7 | 2.7 | 2.6 | 1.7 | 2.0 | 2.5 | 2.5 | 2.7 |
| *Tropical Atlantic, Eastern* | 1,996.7 | 2,203.6 | 2,347.7 | 2,705.6 | 3,060.9 | 3,448.1 | 3,833.5 | 4,577.3 | 4,655.8 |
| Coastal and off-shore fish | 1,864.4 | 2,073.6 | 2,237.9 | 2,544.6 | 2,910.2 | 3,288.3 | 3,639.2 | 4,372.6 | 4,458.6 |
| Oceanic fish, Total | 132.3 | 130.0 | 109.8 | 161.0 | 150.7 | 159.8 | 194.3 | 204.7 | 197.2 |
| Large tunas | 115.9 | 106.0 | 89.8 | 129.2 | 120.8 | 111.4 | 130.2 | 135.7 | 139.7 |
| Skipjack | 16.4 | 24.0 | 20.0 | 31.8 | 29.9 | 48.4 | 64.1 | 69.1 | 57.5 |
| *Tropical Indian Ocean* | 1,872.2 | 2,049.2 | 2,054.9 | 2,145.8 | 2,180.3 | 2,368.2 | 2,656.9 | 2,402.8 | 2,614.8 |
| Coastal and off-shore fish | 1,776.8 | 1,951.1 | 1,925.7 | 1,984.3 | 2,053.1 | 2,267.9 | 2,534.1 | 2,324.8 | 2,508.6 |
| Oceanic fish, Total | 95.4 | 98.1 | 129.2 | 161.5 | 127.2 | 100.3 | 122.8 | 78.0 | 106.2 |
| Large tunas | 82.4 | 82.1 | 111.8 | 144.9 | 108.5 | 80.2 | 93.8 | 61.7 | 86.1 |
| Skipjack | 13.2 | 16.0 | 18.1 | 16.6 | 18.7 | 20.1 | 29.0 | 16.3 | 20.1 |
| *Tropical Pacific, Western* | 2,652.0 | 3,020.0 | 3,219.0 | 3,679.0 | 3,948.0 | 4,176.0 | 4,520.6 | 4,740.0 | 5,036.0 |
| Coastal and off-shore fish | 2,652.0 | 2,914.2 | 3,136.8 | 3,595.7 | 3,866.4 | 4,082.1 | 4,397.6 | 4,612.2 | 4,867.7 |
| Oceanic fish, Total | – | 105.8 | 82.2 | 83.3 | 81.6 | 93.9 | 122.4 | 127.8 | 168.3 |
| Large tunas | – | 70.1 | 47.0 | 40.8 | 40.1 | 39.5 | 37.7 | 43.8 | 52.9 |
| Skipjack | – | 35.7 | 35.2 | 42.5 | 41.5 | 54.4 | 84.7 | 84.0 | 115.4 |
| *Tropical Pacific, Eastern* | 542.9 | 559.4 | 686.2 | 725.3 | 664.0 | 744.7 | 766.8 | 839.8 | 994.5 |
| Coastal and off-shore fish | 306.3 | 356.4 | 433.5 | 498.2 | 427.8 | 473.6 | 502.8 | 543.9 | 721.6 |
| Oceanic fish, Total | 236.6 | 203.0 | 252.7 | 227.1 | 236.2 | 271.1 | 264.0 | 295.9 | 272.9 |
| Large tunas | 160.3 | 148.8 | 145.8 | 152.6 | 184.7 | 212.8 | 182.6 | 243.8 | 224.1 |
| Skipjack | 76.3 | 54.2 | 106.9 | 74.5 | 51.5 | 58.3 | 81.4 | 52.1 | 48.8 |

**Figure 2**

**Annual catch from tropical waters by fish and country groups. Coastal and off-shore fish comprise pelagic and demersal fishes, and oceanic fish are larger tunas and skipjack**

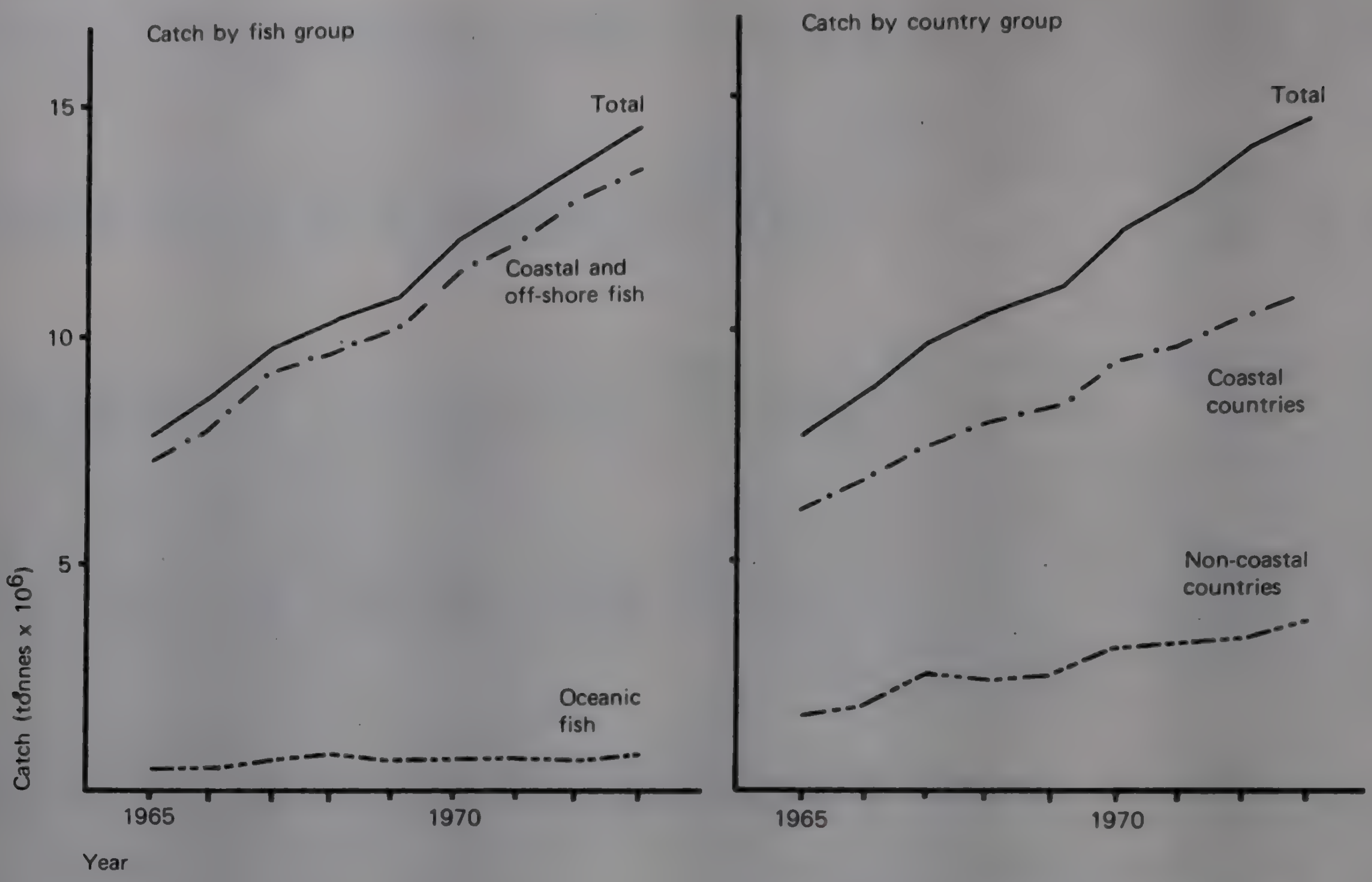


**Figure 3**

**Annual catch of oceanic fish from tropical waters by species group**

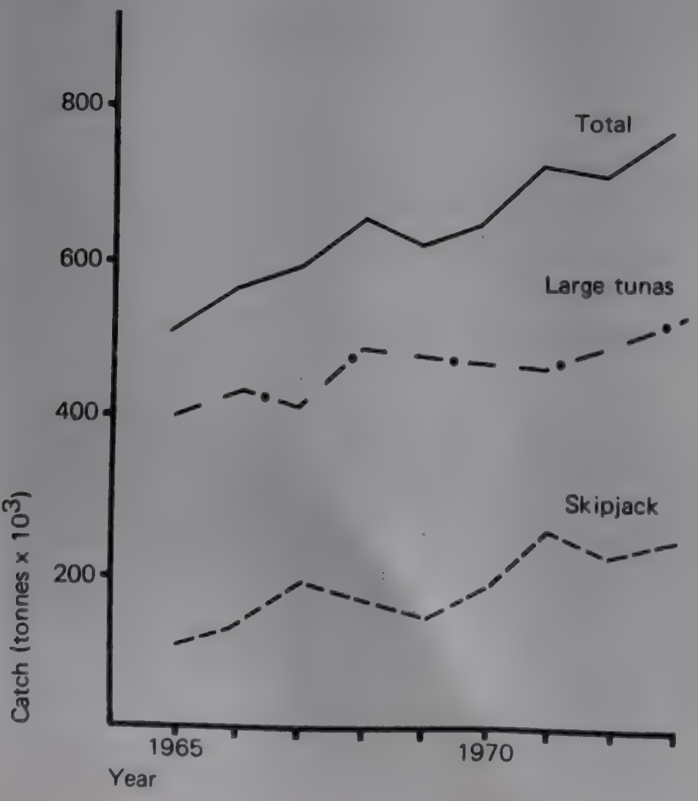


**Figure 4**

**Annual change in the catch of non-coastal countries from the tropical sea by region**

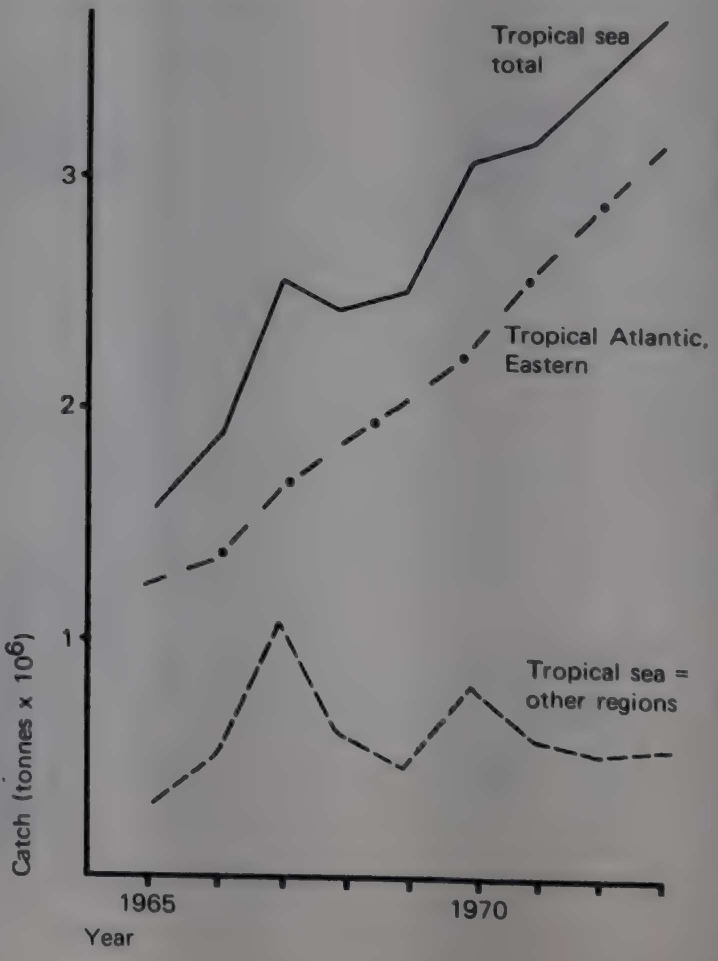
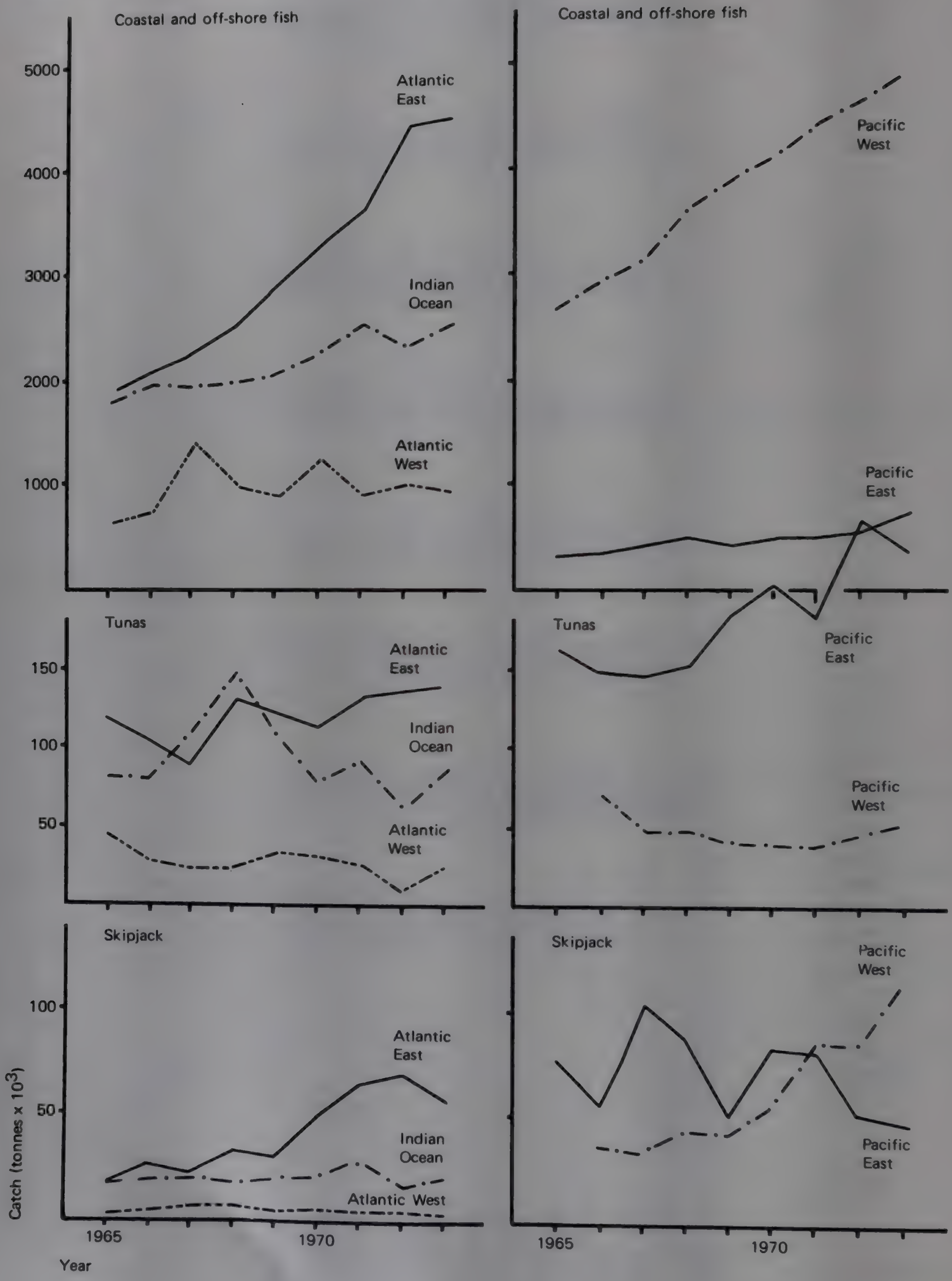


TABLE 3. *Annual catch from the tropical waters by country group (tonnes x $10^3$)*

| *Region and country group* | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|---|---|---|---|
| *Tropical Atlantic, Western* | 684.2 | 775.4 | 1,422.0 | 1,017.2 | 885.2 | 1,256.9 | 946.8 | 1,038.0 | 1,003.0 |
| Coastal countries | 613.4 | 630.6 | 699.0 | 803.5 | 768.7 | 810.4 | 893.0 | 948.8 | 963.0 |
| Non-coastal countries | 70.8 | 144.8 | 723.0 | 213.7 | 116.5 | 446.5 | 53.0 | 89.3 | 40.0 |
| *Tropical Atlantic, Eastern* | 1,996.7 | 2,203.6 | 2,347.7 | 2,705.6 | 3,060.9 | 3,448.1 | 3,833.5 | 4,577.3 | 4,655.8 |
| Coastal countries | 738.3 | 843.5 | 863.5 | 857.4 | 1,024.9 | 1,203.4 | 1,262.9 | 1,717.5 | 1,542.5 |
| Non-coastal countries | 1,258.4 | 1,360.1 | 1,484.2 | 1,848.2 | 2,031.5 | 2,244.7 | 2,570.6 | 2,859.8 | 3,113.3 |
| *Tropical Indian Ocean* | 1,872.2 | 2,049.9 | 2,054.9 | 2,145.8 | 2,180.3 | 2,368.2 | 2,656.9 | 2,402.8 | 2,614.8 |
| Coastal countries | 1,742.6 | 1,884.6 | 1,881.2 | 1,993.6 | 2,032.9 | 2,229.3 | 2,326.1 | 2,200.6 | 2,483.7 |
| Non-coastal countries | 129.6 | 164.6 | 173.7 | 152.2 | 147.4 | 138.9 | 330.8 | 202.2 | 131.1 |
| *Tropical Pacific, Western* | 2,652.0 | 3,020.0 | 3,219.0 | 3,679.0 | 3,948.0 | 4,176.0 | 4,520.0 | 4,740.0 | 5,036.0 |
| Coastal countries | 2,652.0 | 2,896.7 | 3,123.8 | 3,585.7 | 3,854.1 | 4,069.7 | 4,393.3 | 4,611.1 | 4,874.2 |
| Non-coastal countries | – | 123.3 | 95.2 | 93.3 | 93.9 | 106.3 | 126.7 | 128.9 | 161.8 |
| *Tropical Pacific, Eastern* | 542.9 | 559.4 | 686.2 | 725.3 | 664.0 | 744.7 | 766.8 | 839.8 | 994.5 |
| Coastal countries | 431.6 | 473.5 | 593.5 | 590.7 | 547.3 | 622.5 | 682.7 | 736.4 | 772.9 |
| Non-coastal countries | 111.3 | 85.9 | 92.7 | 134.6 | 116.7 | 122.2 | 84.1 | 103.4 | 221.9 |

**Figure 5**
**Annual change in the catch from the tropical waters by fish group and region**



### *Annual change in the catch from the sea*

The great increase of the catch from the sea obviously derived from the catch of coastal and off-shore fish, which consisted of various pelagic and demersal species (Figure 2). At 13 million tonnes, the 1973 marine catch was nearly twice that taken in 1965 (7.2 million tonnes).

In contrast the catch of oceanic fish, mainly large tunas and skipjack, has not increased as much; it increased by only 260,000 tonnes during 1965–73, to 150 per cent of the 1965 catch (Figures 2 and 3). However, the situation is quite different between the components of this fish group. The growth in skipjack catch has been remarkable, doubling during 1965–73; while the catch of large tunas has remained almost constant since 1967 (Figure 3).

Countries within the tropical areas have achieved great progress, increasing their catch by about 4.5 million tonnes from 1965–73 (Figure 2). Other countries with distant-water fleets, such as USSR, Spain, Japan, Republic of Korea, Norway, Poland, Italy, France, Romania and Greece, have increased their catch from these areas by 2 million tonnes in this period. The statistics show that the increase of the catch by these countries has mostly taken place in the Eastern Atlantic (Figure 4). This is a unique phenomenon in world tropical waters as the catch from the other three regions has remained almost at the same level or decreased in recent years (Tables 2 and 3).

### *The catch from the sea by fish group*

*Coastal and off-shore fish:* Major resources included in this fish group are sardines, sardinellas, horse mackerels, jack mackerels and anchovies among pelagic fish; and hakes, sea breams, flounders, soles, cephalopods and shrimps among demersal fish. The catch statistics for this group of fish show that the largest production has been achieved in the Western Pacific, followed by the Eastern Atlantic (Table 3, Figure 5). In these two regions the catches have increased greatly since 1965, and the catches in 1973 were much larger than those in other regions. The catch from the Indian Ocean in early years was at nearly the same level as in the Eastern Atlantic and the Western Pacific, but it has not increased as much.

*Large tunas:* This group consists of bluefin tuna, yellow fin tuna, albacore and big-eye tuna. The statistics show that, for each region except in the Eastern Pacific, the catch has changed little. The catch in the Eastern Pacific has increased since 1969, as a result of the increased catch of yellowfin tuna, taken mostly by USA and Ecuador.

*Skipjack:* Unlike the catch of large tunas, the catch of skipjack has increased remarkably in the Western Pacific and the Eastern Atlantic. The catch in the Western Pacific doubled between 1966 and 1973; mainly by the efforts of Japanese companies. The increase of the catch in the Eastern Atlantic derived from the catches taken by Japan, France and Spain. The catch in the Eastern Pacific shows a tendency to decrease with large fluctuations since 1965. The catch in the Western Atlantic has remained at a low level during the period.

### *Annual change in the catch from inland waters*

The growth in the catch from tropical inland waters in recent years is not as great as the growth of the marine catch. However, the catch shows a gradual increase from 1965, and in 1973 it was about 114 per cent of that in 1965 (Table 4 and Figure 6). The catch in 1973 (3.6 million tonnes) forms about 37 per cent of the total world catch from inland waters (9.8 million tonnes).

The largest catch has been achieved by Asia, the second largest by Africa. The catch from these two regions shows an increasing tendency in recent years, while the catch from South America has remained at almost the same low level during the period (Figure 6).

**Figure 6**
**Annual change in the catch from the inland waters in the tropics by region**

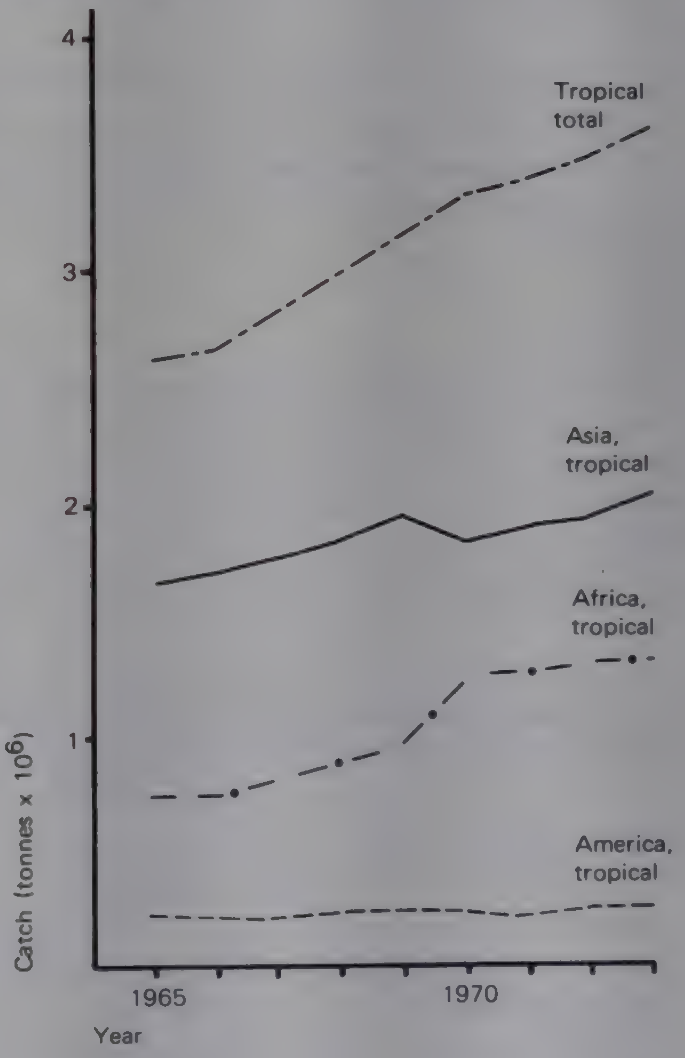


TABLE 4 *Annual nominal catch from the inland waters in the tropical countries (tonnes x* $10^3$*)*

| *Region* | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|---|---|---|---|
| Africa | 748.6 | 755.2 | 828.9 | 897.6 | 971.4 | 1,253.4 | 1,284.9 | 1,313.6 | 1,319.3 |
| Asia | 1,677.8 | 1,713.2 | 1,797.0 | 1,864.6 | 1,963.2 | 1,844.8 | 1,904.6 | 1,947.5 | 2,064.8 |
| America | 228.0 | 226.0 | 224.8 | 245.7 | 259.5 | 256.0 | 229.2 | 255.1 | 263.9 |
| *Total* | 2,654.4 | 2,694.4 | 2,850.7 | 3,007.9 | 3,194.1 | 3,354.2 | 3,418.7 | 3,516.2 | 3,648.0 |

TABLE 5 *Estimated exploitable potential of coastal and offshore fishes in the tropical waters by region and fish group*

| *Region and fish group* | *Potential (tonnes x $10^3$)* | *Status of exploitation* |
|---|---|---|
| *Tropical Atlantic, Western* | 1,790 | |
| Pelagic fish | 600 | Lightly exploited |
| Demersal fish | 1,000 | Moderately exploited |
| Shrimps | 190 | Fully exploited |
| *Tropical Atlantic, Eastern* | 3,850 | |
| Pelagic fish | 3,000(1) | Moderately, but locally fully exploited |
| Demersal fish | 550(1) | Fully exploited |
| Cephalopods | 250 | Fully exploited |
| Shrimps | 50 | Fully exploited |
| *Tropical Indian Ocean* | 13,730 | |
| Pelagic fish | 6,000 | Mostly moderately exploited |
| Demersal fish | 7,500(2) | Lightly exploited |
| Shrimps | 230 | Fully exploited |
| *Tropical Pacific, Western* | 8,600 | |
| Pelagic fish | 4,000 | Mostly lightly exploited |
| Demersal fish | 4,300 | Moderately exploited |
| Shrimps | 300 | Moderately, but locally fully exploited |
| *Tropical Pacific, Eastern* | 1,625 | |
| Palagic fish | 1,500 | Moderately exploited |
| Demersal fish | 50 | Moderately exploited |
| Shrimps | 75 | Fully exploited |

(1) Seems to be under-estimated, compared with the nominal catch

(2) Seems to be over-estimated, comparing the extent of the continental shelf in this and other regions.

The figures were mostly cited from FAO Fisheries Circular No. 313 (1973), and some supplementary corrections were made according to the additional information in FAO Fisheries Circular No. 328 (1974)

TABLE 6 *Estimated exploitable potential for oceanic fishes in tropical waters*

| *Region and species group* | *Potential (tonnes x $10^3$)* | *Status of exploitation* |
|---|---|---|
| *Atlantic Ocean* | 500 | |
| Large tunas | 225 | Fully exploited |
| Skipjack | 275 | Moderately exploited |
| *Indian Ocean* | 340 | |
| Large tunas | 110 | Fully exploited |
| Skipjack | 230 | Lightly exploited |
| *Pacific Ocean* | 1,050 | |
| Large tunas | 400 | Fully exploited |
| Skipjack | 650 | Moderately exploited |

Source: Gulland, 1971

TABLE 7 *Comparison of the nominal catch in 1973 and the estimated potential by region in tropical waters (tonnes x $10^3$)*

| *Region* | *Coastal and off-shore fish* | | *Oceanic fish* | | | |
|---|---|---|---|---|---|---|
| | *Pelagic and demersal fish* | | *Large tunas* | | *Skipjack* | |
| | *Catch* | *Potential* | *Catch* | *Potential* | *Catch* | *Potential* |
| Tropical Atlantic, Western | 975.0 | 1,790 | 165.0 | 225 | 60.2 | 275 |
| Tropical Atlantic, Eastern | 4,458.6 | 3,850(1) | | | | |
| Tropical Indian Ocean | 2,508.6 | 13,730(2) | 86.1 | 110 | 20.1 | 230 |
| Tropical Pacific, Western | 4,867.7 | 8,600 | 277.0 | 400 | 164.2 | 650 |
| Tropical Pacific, Eastern | 721.6 | 1,625 | | | | |
| *Total* | 13,531.5 | 29,595 | 528.1 | 735 | 244.5 | 1,155 |

(1) Seems to be under-estimated, see Table 5

(2) Seems to be over-estimated, see Table 5

## Estimated exploitable potential and status of exploitation

### *Coastal and off-shore fish*

The author thinks that the Western Pacific has the largest potential among the tropical regions of the world (Table 5). The estimates cited here show that the Indian Ocean has the largest potential in the world. However, the figure for this region has to be taken at some discount; the figures seem to be over-estimated, possibly due to the lack of sufficient research and survey date. It is obvious that the estimate for demersal fish in the Indian Ocean is too large, judging from the comparison of the extent of continental shelf in the region with that in the other regions. Apart from this problem, it is agreed in general that the Indian Ocean has large pelagic and demersal resources. The level of exploitation in the Western Pacific and the Indian Ocean is still very small.

The Eastern Atlantic has the second largest potential as a whole, but the resources in this region seem to be intensively exploited already. The Western Atlantic and the Eastern Pacific have relatively small potentials. The author thinks it is quite reasonable to assume that the potential of demersal fish in the Eastern Pacific is very low due to the topography of the region.

Shrimp resources have some potential as a whole, but it seems that almost all the resources have been fully or heavily exploited already. Cephalopods have some potential, but the resources have been fully exploited already and over-exploited in some local waters.

### *Oceanic fish*

The Pacific Ocean has the largest potential for oceanic fish, it is more than double that of either of the other oceans (Table 6).

As far as the quantity which can be taken from the sea as protein material for human consumption is concerned, the total potential of tropical waters for this group of fish is very small (1.9 million tonnes) compared with that of coastal and off-shore fish (29.6 million tonnes) Table 7. But these types of fish, especially the larger tunas, fetch high prices, which is of great interest to the fishermen. This situation is considered to be one of the reasons which has led almost all large tuna resources to be heavily or over-exploited. The skipjack resources have not yet been fully exploited, and still have a large unexploited potential.

### *Inland waters*

There is no available information on the potential of inland waters in the tropics from the world-wide point of view. However, judging from the biological features of inland waters and the historical development of inland water fisheries, it seems unlikely that inland waters can produce large yields except by aquaculture. As to additional production, some increase can be expected from the inland waters of South America and in undeveloped inland waters such as those of Papua New Guinea.

## Discussion

A comparison of the nominal catch in 1973 (the latest data and the largest catch) with the estimated exploitable potential from tropical seas is shown by region in Table 7. The author discusses below the possibility of additional exploitation in the future mostly based on this comparison.

### *Coastal and off-shore resources*

It seems that, on the whole, the resources in the Eastern Atlantic have been fully exploited already although there may be some local stocks which could be harvested more intensively. Pelagic and demersal resources in the Western Atlantic and pelagic resources in the Eastern Pacific seem to have some capacity for increased catches.

The resources in the Indian Ocean are reputed to have large potential for exploitation, but the estimated potential is almost surely too high, as mentioned earlier. However, there is no doubt that the Indian Ocean can still be further utilized; according to the information obtained from the UNDP/FAO Pelagic Fishery Project (UNDP/FAO, 1974), there are large stocks of sardine and mackerel in the Indian Ocean which have been only lightly fished. The slow increase of the catch in this region in recent years (Figure 5) is considered to have resulted not from the capacity and characteristics of resources, but from the slow development of the fisheries of this region.

The resources in the Western Pacific have the largest potential in tropical waters. Both pelagic and demersal resources can be further exploited in this region.

### *Oceanic fish*

*Large tunas:* As was pointed out, most of the large tuna stocks have been fully or over-exploited already although the figures in Table 7 show some increased potential in each region. Several measures to sustain the stock levels or to restore depleted stocks have already been implemented. Therefore, not much additional production of large tunas can be expected.

*Skipjack:* Skipjack resources in every region allow for more exploitation. Both the nominal catch and the unexploited potential are largest in the Pacific, and many developing countries in this region are planning or have begun skipjack fishing. In the other two oceans there are large resources to be exploited (Table 7).

From the practical point of view, there are of course many problems to be solved in the skipjack fishery such as cost and efficiency of vessels, skill of crew, gear and bait, processing facilities, market demand, extended fisheries jurisdiction by coastal states, etc. Technical and commercial considerations may restrict rapid expansion of this fishery even though the biological potential is obviously promising.

### *Inland waters*

Although there is a limited information on the unexploited potential of inland waters, it is clear that a large increase in production from inland waters cannot be expected, except by aquaculture. The expansion of production in South America and some developing countries in the Western Pacific can be expected, but the quantity will not be large in terms of the total world catch, though it may be significant locally.

### *Other resources*

The author dealt hitherto only with the conventional resources which have been harvested by traditional methods and have had rather stable market demands over a long period. Recently, such unconventional resources as *Euphausia,* red crab, oceanic squid, lanternfish, and seaweed have received attention owing to worldwide food problems (Alverson, 1975). The outstanding example among these non-conventional resources is the well known Antarctic krill, which has already been utilized experimentally and it may be possible to utilize other unconventional resources. But the author thinks that, at the moment, these groups of resources will remain for a while in the category of 'exploitable biomass' rather than the category of 'resources' for human consumption, because the practical and industrial base may not be established in the near future.

### References

**Alverson, D. L.** (1975) Opportunities to increase food production from the world's ocean. *Mar.Technol. Soc.J.,* 9(5), 33–40.

**FAO** (1973) Review of the status of some heavily exploited fish resources. *FAO Fisheries Circular* No. 313, 39 pp.

**FAO** (1974a) *Yearbook of fishery statistics, Volume 36, Catches and landings, 1973.* 590 pp.

**FAO** (1974b) Review of the status of exploitation of the world fish resources. *FAO Fisheries Circular* No. 328, 26 pp.

**Gulland, J. A.**, ed (1971) *The fish resources of the ocean.* Surrey, England: Fishing News (Books), 255 pp.

**UNDP/FAO Pelagic Fishery Project** (1974) *Progress Report* No. 8. Results of the 1973 aerial survey, 17 pp.

# Technology in fisheries development in the tropics

**N. R. Jones and J. G. Disney**
Tropical Products Institute, UK

## Summary

The paper discusses the inter-relationships between the technologies of fish handling, preservation, processing, transportation and marketing in the wider context of fisheries development, with the intention of providing a framework for the following sessions of the Conference.

Fishing industries in developing countries at different stages of development are discussed. Desirable levels of technology are considered in the light of the sociological and economic conditions. Particular attention is given to the differing demands of local and export markets. The current state of knowledge on the spoilage processes in tropical food fish is also reviewed and the need for further research is indicated. Differences between tropical fish and temperate- or cold-water fish are noted, but the paper argues that significant improvements can be introduced to traditional processes from the knowledge available, at relatively little cost. At higher levels of technology the technico-economic problems that have arisen in practice are discussed together with their implications to other aspects of fisheries development, e.g. training and wider integration with other food industries.

## Résumé

L'article étudie les relations entre les technologies de la manipulation du poisson, de sa conservation, de sa préparation, de son transport et de sa commercialisation dans le contexte plus large du développement de la pêche dans l'intention de fournir un cadre pour les sessions ultérieures de la Conférence.

Les industries de la pêche dans les pays en voie de développement aux divers stades de développement sont passées en revue. Les degrés souhaitables de technologie sont examinés à la lumière des conditions sociologiques et économiques. Une attention particulière est portée aux différentes exigences des marchés locaux et d'exportation. La connaissance actuelle des procédés concernant les déchets de poissons tropicaux est également passée en revue et la nécessité d'études plus poussées est prise en considération. Les différences entre les poissons tropicaux et les poissons des mers tempérées ou froides sont notées mais dans cet article il est fait état du fait que des améliorations significatives peuvent être apportées aux procédés traditionnels grâce aux connaissances disponibles pour une dépense relativement faible. A de plus hauts niveaux de technologie, les problèmes économiques et techniques qui se sont posés dans la pratique sont discutés ainsi que leurs implications dans d'autres aspects du développement de la pêche, par exemple formation et intégration plus complètes à d'autres industries alimentaires.

## Resumen

El artículo trata de las interrelaciones entre las técnicas de manejo, conservación, elaboración, transporte y comercialización del pescado en el amplio contexto del desarrollo de la industria pesquera, con la intención de proporcionar una estructura para las siguientes sesiones de la Conferencia.

Se examinan las industrias pesqueras de los países en diferentes niveles de desarrollo. Se consideran los niveles tecnológi cos deseables a la luz de las condiciones sociológicas y económicas. Se concede particular atención a la diferente demanda de los mercados locales y de exportación. También se revisa el estado actual de los conocimientos sobre los procesos de deterioro en los pescados tropicales comestibles y se indica la necesidad de una investigación más amplia. Se señalan las differencias entre los pescados tropicales y los de aguas templadas o frias, sosteniendo, sin embargo, que se pueden llevar a cabo mejoras significativas con respecto a los procesos tradicionales, a partir de los conocimientos disponibles y a un coste relativamente bajo. A niveles tecnológicos superiores se estudian los problemas técnico-ecónómicos que han surgido en la práctica, junto con sus implicaciones en otros aspectos del desarrollo de las industrias pesqueras, como la formación de personal e integración más amplia en otras industrias de la alimentación.

In this paper, we attempt, together with the excellent FAO review of the resource, to provide an introduction to the specialized sessions of the Conference. In keeping with the theme of these commodity conferences over the years, and accepting, with the Oxford Dictionary definition, that technology is the scientific study of a practical art, we have sought to relate the nature of the raw material of the industry to the factors affecting marketability. The emphasis of the Conference being post-harvest, the technology of fish capture is not considered except in so far as it has handling and marketing implications.

From the FAO paper on the resource situation it appears that production from many tropical waters is likely to increase for some years. In many tropical fisheries, however, maximum sustainable yields have been achieved, or even surpassed, but much of the existing catch is under-utilized. As new resources become scarcer, competition for existing resources increases. The pressures more generally on food supplies grow also, and the requirement to up-grade the post-harvest sector of the industry increases in parallel. At the same time, the quality of life of the fisherman and his family in many developing countries adds urgency to the need to improve the returns on his often hazardous labour.

It would be unrealistic to argue that technological innovation alone will contribute a decisive input, particularly to that section of the industry, the artisanal fisherman, most in need. Scientific contributions to 'practical art' must give precedence to the 'art of the possible'. At the 1973 Committee on Fisheries meeting in Rome Ripley of UNDP pointed out that any effective action to develop small-scale fisheries in developing countries must be taken by governments. He noted that the small fishermen are usually 'voiceless, politically powerless and live in remote places where few administrators and politicians ever go'. The Conference may or may not agree some or any of this view. Certainly there are some notable localized exceptions. Most would agree however that the artisanal fisherman, lying at one end of a discontinuous spectrum of tropical fisheries technology, is not the easiest subject for assistance.

Above this level, the fisheries industry ranges, through short trip, inshore operations, to long distance catcher-freezer and shipboard factory-processor operations comparable in sophistication with those of the most advanced fisheries. In many instances this last category is operated by developed, industrial countries, sometimes in joint venture or trans-shipment arrangement with a developing country. The main thrust of the Conference's deliberations seeks to establish what might most usefully be done for the artisanal and more industralized near-water fisheries.

## Production for internal and export markets

Several industries, for instance that of India, have undergone considerable changes during the past decade. A considerable export industry for frozen and canned *Crustacea* has been developed from hitherto under-exploited resources. By comparison, distant-water tropical tuna fisheries have been long exploited, particularly, by developed countries. Efforts to develop international markets for tropical and subtropical 'white' fish (for instance the hakes and the pomphrets) are now being pursued actively by countries newly entering the field. Under the encouragement of certain aid agencies, consideration is also being given to the production of frozen minces from species, unlikely to be marketable internationally, in more conventional form.

The structuring of this Conference recognizes the difficulties which sections of the export industry have encountered in importing countries fearful for the transmission of food-borne disease. While it is clear that high microbiological standards can be met in tropical countries, it is apparent, from the incidence of complaints and rejections, that the levels of public health education and technical and infrastructural development in some countries can precipitate serious problems of production and marketing. Frozen prawns and frogs legs have been particularly troublesome. These difficulties have extended even into the fishmeal industry in the context of animal disease and possible transmission to Man through stock.

Analogous technical problems arise in servicing internal markets. In so far as local governments consider regulation of supply and quality advisable or practicable they have, for instance, to consider how far the guidelines, offered by Codex Alimentarius and the Codes of Practice, are applicable to their own conditions. There may be a case for the adoption of modified codes and standards in some country situations. (Current handling codes are based on good cold/temperate fishery practice and are not necessarily relevant in the tropics.) A recurring problem in food supplies, of equating quality to quantity, indicates such approaches to be realistic while affording bases for improvement in the longer term.

In considering technological improvement for the local market, it is necessary to take note of the very wide variations in consumer preferences and to balance experience of changing patterns of acceptability in some populations against the deeply entrenched conservatism of others. Such factors, obvious to indigenous specialists, may not be readily apparent to 'outside' technical advisers lacking the language or sociological background. Examples will emerge in the Conference. Reference may perhaps be made however to the preference for strongly 'off' flavoured dried fish in parts of West Africa and the frequent desire of the housewife, throughout the tropics, to receive her fish head-on, guts-in. It is particularly important to appreciate the effects of religious attitude in marrying technological development to the formulation of marketing policy.

Together with such considerations of official and consumer requirements in the internal and external markets, the technologist has to consider the constraints operating within the marketing 'system'. Not infrequently, for instance, ice, which can be in serious short supply, is in the hand of middlemen or agents of plants, to whom the fishermen (for reasons of seasonality of the fishery – or others) are heavily indebted. Local pricing constraints operating within co-operatives, arising under governmental direction, or often dictated by the purchasing limitations of the consumer population, may limit the practicability of applying the higher technologies. In such situations the technologist will seek to identify and apply optimal solutions.

## Some areas of possible technological contribution to development

The contribution of post-harvest technology to wider programmes of fisheries development and food production lies (i) in improving the economics and total production of the industry through the avoidance of gross wastage (spoilage, dumping of trash fish) (ii) in improvement of yield and quality taking into account sociological factors, the adequacy of return on investment and the wider considerations of food safety.

Food wastage was a major concern of the recent World Food Conference. Subsequent efforts to quantify losses adequately have encountered difficulties of definition; these extend to fisheries, for example: Is fishmeal production, from species difficult to process for human consumption, to be regarded as wasteful? A contribution from the FAO adds to our knowledge of the subject in relation to developmental constraints. For present purposes, however, two broad categories of wastage may be distinguished:

(1) Large quantities of fish, for instance the shrimp by-catch, are discarded on the vessel because currently it is uneconomic to preserve and land them. Other large resources potentially of use for human consumption (eg small pelagic species) are also under or un-exploited. Approaches to the utilization of the by-catch will be discussed later in Session 5 of the Conference; it should be noted however that at least one country has insisted that a proportion of the fish caught by shrimpers should be landed as fish for human consumption.

(2) Considerable wastage of fish occurs after capture. Microbial spoilage represents the most serious loss of wet fish, and, as indicated above, further serious problems can arise from contamination by pathogenic micro-organisms. Technologies for control are well established; the problems arising, by and large, in application. As indicated below, however, the particular properties of tropical fish spoilage microfloras and those of their enzymes offer opportunities for extended, cheap, chill storage.

Substantial spoilage losses occur also in processed products, for instance the accelerated 'blowing' of canned products. Problems arise particularly in the dried fish industries. Reference has been made above to the microbiological problem. Oxidation problems, partially controllable by adequate handling and storage techniques, can arise with fatty species. Particularly serious however are the problems of insect infestation. Dried fish is still a significant element of the export industries of some countries and an important source of low-cost protein within producer countries. Losses as high as 50 per cent are reported in some situations. Control procedures range from better 'home keeping' to the use of appropriate insecticides.

Any consideration of technological inputs must refer to 'transference of technology', which the literature commonly takes to infer a movement of the sophisticated technologies from the industralized countries to the under-developed. There is also a movement publicising the merits of small-scale technological transfer but again this is usually based substantially on western technology. There is relatively little in the literature on the undoubted merits of many of the indigenous technologies of the tropics or possibilities for improving their performance. In many developing fisheries transference of technologies has been, at best, only partially successful. There has also been an incomplete appreciation of socio-economic factors, particularly the capacity of the local industry to adapt quickly and to evaluate possibilities accurately. Later in this paper we touch upon aspects of post-harvest fisheries science, arguing for somewhat different approaches to tropical fish technology. In these respects it is clear that transference of the technology of colder fisheries is not indicated.

In common with many fishery institutions world-wide, there exists in many developing countries an element of parochialism that ignores the wider role of post-harvest fisheries development in food industries more generally. This is unfortunate in servicing an industry that can be seasonal in character and in which plant, which could be used profitably for other commodities, can be idle for several months of the year. It is encouraging to note that, in parallel with food industries elsewhere, certain developing countries are increasingly aware of these possibilities.

## Commentary on optimal handling and processing technologies

The impact of socio-economic factors on fish technology has already been noted. We attempt, by a short reference to the current knowledge of tropical fish microbiology, enzymology, chemical stability characteristics and entomology, to give an introduction to the technical sessions of the Conference. Of necessity this is not exhaustive, even for a subject in which the literature is sparse and in which there are serious gaps in our knowledge. At the time of writing it is apparent that many of the papers of the Conference will make considerable contributions. In the concluding session we should be in a position to draw firmer conclusions and, hopefully, to give some pointers to further development in the post-harvest sector.

### *Handling of wet fish*

Fish is a notoriously perishable commodity. In the tropics, at ambient temperatures, spoilage is rapid, occurring within 24 hours. In ice, however, tropical species (with the exception of cold-water living hakes etc) keep for extensive periods, by comparison with those of colder waters. Shelf lives of up to 45 days have been recorded for some species, 20 to 30 days being common. It is postulated that this results from the greater temperature differential on the spoilage microflora and tissue enzymes. The relationship between spoilage and bacterial count also appears to be different with reports of lower counts at the limit of edibility. Dangers of contamination with pathogens against the background of under-developed infrastructuring and public health education have already been indicated with respect to the handling of wet fish.

Results on the effects of heading and gutting tropical species indicate that there is little, if any, advantage in terms of keeping quality. It appears that the additional handling involved introduces some incidental hazard. There is a need for further investigative study in this field. For many indigenous markets where the intact fish is preferred it may well be that the common technical advice is erroneous. Where transportation costs are high or there is a requirement to disguise an unaccustomed species, additional processing to the extent of filleting or mincing, may be indicated.

In the current state of knowledge, it seems unwise to over-generalise. For instance, there is evidence of a limited nature that delays of some 6 hours at ambient temperature may be permissible for some species before icing without detriment to longer-term shelf life. The relationship to incidental handling and gutting has not been fully established. For some species chilling to 3–5°C is permissible.

In the context of transference of technology, as we have seen, established guidelines can be misleading. Tropical fish often spoil more rapidly than cold-water fish if allowed to remain unchilled but keep longer if chilled. It may well be unnecessary to advise very short-trip fishermen to take ice (which they can ill afford and which may in any case not be available) to sea. For many distribution channels it appears that a chill chain would suffice for periods that in many northern, developed industries would indicate the use of a cold chain. Particularly in the context of the export industry, considerably greater attention should be given to cleanliness of handling and the quality of water supplies. Common malpractices such as sorting on fouled ground and washing of shrimp in dock water are not to be tolerated.

Mention should be made of rigor and connective structure control, which have relevance to yield and texture of fish. Among tropical and subtropical species, problems can arise when cold-current fishes (eg the hakes) are brought to a hot deck through warm surface waters. Contrary to the general indications above, such fish should be chilled as soon as possible. In the wider context of rigor phenomena there is a little evidence that rapid chilling could be detrimental to some warmer-water-adapted species. A 'cold-shock' hardening of pre-rigor musculature has been observed that is possibly analogous to that causing serious difficulties in the meat industry. Again, more work is required in this area before any definitive conclusions can be drawn. In some respects the technology of warm-water species appears to have closer similarities to meat technology than to cold-water fish technology. Such considerations relate to guideline Codes of Practice and quality standards which may require amendment in some instances.

In difficult situations, where chilling facilities may not be available, shade and evaporative cooling are of limited value.

### *Freezing*

Notwithstanding the indications above, progress has been made in West and Central Africa, Sri Lanka, India and elsewhere on freezing for the internal markets. The economics are not markedly different from those of iced distribution in some situations but the maintenance of adequate storage and cold chains is difficult in many tropical countries.

A considerable industry has developed for the exportation of frozen prawns, the problems being primarily those of pre-handling (above). By and large, the well known 'black spot' phenomenon is controllable by chilling and the use of sulphite.

It is not proposed to discuss the well-established frozen tuna industry at length in this Conference. Most tuna are brine frozen at sea and the two main fishing methods each involve handling problems. The purse seiner takes its catch at uneven intervals, and this must be considered when designing the plant, 20 tonnes or more being taken per haul. Two major problems have arisen in canning frozen tuna, honeycombing and 'green' tuna. The former derives from a spoilage condition pre-harvest and the latter is haem pigment related, commonly controlled by pre-testing, being related to trimethylamine oxide content.

In general, while there is considerable commercial experience of the cold storage of a number of commercially important species there is little well documented literature on other species of potential value. Information is required particularly on time/temperature tolerances. Perhaps what is most needed in the field is work to ascertain to what degree the cheapest (as distinct from the 'best') practices can provide acceptable quality and adequate storage life. In this respect the newer technologies of mince production, forming and freezing are of considerable interest.

### *Canning*

Reference to canning under tropical conditions is made in Session 6 of the Conference. Maintenance of canned produce in acceptable condition in tropical countries can give rise to problems of corrosion and premature 'blowing' by comparison with conditions in most developed countries. Problems of cooling water quality can also arise.

With respect to the pre-cook phase of processing it has been noted that under West African conditions, hot air cooking with inversion of the can has been preferred to oil which cannot under local conditions be replenished fresh at an economic rate.

### *Drying, smoking, salting, sauces*

The bases of these technologies are well established. Under many tropical conditions, the heat stability of musculature allows the use of higher drying temperatures than for cold-water species. Difficulties arise particularly in maintaining even minimal cleanliness under conditions pertaining in many developing countries. The common shortage of wood fuel has pointed to the need for the further development of cheap, efficient kilns. There is a considerable problem of insect infestation, the subject of detailed Conference papers.

Reference should also be made in the context of drying to the well-established fishmeal industry and to Fish Protein Concentrates. These, in the cheaper forms are still the subject of considerable interest in many less developed countries, although they face severe competition from some of the plant proteins and have some acceptability problems.

Extensive industries exist in SE Asia for the production of boiled salted products, and fish sauces. Some progress has been made recently in modifying production procedures for the latter to accelerate the process, if at some quality penalty.

## Conclusion

This paper has stressed the inter-relationships between socio-economic factors and meaningful technological input. Many attempts to solve developmental problems have failed, not because the technology was faulty basically, but because the social or economic climate was not conducive to change.

We have discussed, to some extent, the effect of poor infrastructure, such as water supply, and lack of education. We have not touched upon the often crucial difficulties of lack of trained personnel, particularly at the extension level, without which no amount of research, for instance, will be translated into development in the poorest sector. This we feel may be the most important session of the Conference. It seems to us that only the indigenous specialist in the field, strongly supported by government, will find many of the key answers. We have indicated however that appropriately directed applied research which does not accept the common 'dogmas' has pointed some avenues for commercial development employing technologies optimal in the light of local conditions.

In purely technological terms, one of the biggest obstacles to advance is the lack of in-breadth information on tropical species. We need information on quality control parameters on more species, in different geographical situations. We need data on seasonal compositional variations relating to processing character and a greater understanding of the inter-relationships of autolytic and microbial spoilage and their control in tropical species.

This Conference marks a further step forward in the international exchange of information on tropical fish technology and in the collaboration between the developing countries of the tropics and the bi- and multi-lateral agencies. While not giving, by any means, all the background that is required, it promises to yield some useful leads for the advance of the under-developed sector of the industry.

# Discussion

The first session introducing the general theme of the Conference resulted in a discussion on means of developing the resource and on the problems associated with fisheries development.

The discussion was opened by **Kuriyan** commenting on the catch figures for the Indian Ocean quoted in the first paper; he pointed out that 1973 was a year when fish catches were low but that there had been a big increase since then. With regard to inland fisheries, **Kuriyan** throught that saturation point was a long way off, particularly in India. Other delegates questioned the figures and, as the author was not present, **D. James** invited delegates to write to FAO: he mentioned that the Indian Ocean figures are for 1974 and the author felt there was not much room for expansion.

**Krone**, commenting on **Chikuni's** data and suggesting one means of developing the resource, pointed out that the anchoveta off Peru and Chile should be included as potentially available for human consumption. Similarly, the data on catches from tropical waters include sizeable quantities of fish, at present used for fish meal and other non food usage, which could be available for human food.

The possibility of further development of freshwater resources was discussed: **Okedi** pointed out that freshwater fisheries are more labour intensive than marine fisheries. **James** also noted that lower investment is required to develop freshwater resources, and that their exploitation is often of more direct benefit to the local population.

There was also some discussion on the potential for aquaculture. **Sagua** felt that aquaculture in Africa has so far failed to yield the production anticipated in the late 1950s and asked how the high hopes, expressed in the paper, could be realised in tropical Africa. **N. R. Jones** replied that development does take a long time and that more effort is required. **Krone** mentioned the encouraging findings of the recent workshop on aquaculture in Africa.

The remainder of the discussion centred on problems associated with fisheries development and it was stressed that these were amplified in small-scale fisheries. One problem in developing countries is that there may be large differences between urban and rural populations; **Kuriyan** commented that in India, urban populations will accept frozen fish but rural populations will not.

It was suggested by **Levy** that there is little incentive for the small-scale fisherman to increase his catch unless minimum prices for his fish are fixed by the Government. He flet the problem of 'gluts' of fish could be solved by the Government buying the surplus, which is then frozen and stored preferably by a co-operative.

Finally, in response to a question from **Kamari**, **N. R. Jones** replied that it is not essential to apply ice immediately to tropical fish; delays of say 6 to 9 hours prior to icing are permissible for some species of tropical fish in the sense that the shelf life is little affected.

# Session 2

## Microbiology and quality control

**Monday 5th July**
**Afternoon**

Chairman
G. H. O. Burgess
Torry Research Station
UK

Moderator
J. Liston
College of Fisheries
Seattle
USA

Rapporteur
S. O. Talabi
Nigerian Institute for Oceanography and Marine Research
Nigeria

# Fish inspection and quality control in the United Kingdom

**D. T. Jones**
Medical Officer of Health, Port and City of London, UK

## Summary

The historical significance of fish in the British diet is discussed and the history of fish inspection and quality is touched upon.

The traditional view of the risk of food poisoning from fish is set out and mention is made of the changes which have resulted from modern research and epidemiological investigation. The problems posed to the field worker by such organisms as *Vibrio parahaemolyticus* are outlined and the author discusses in detail the methods of handling fish at sea, at the quayside, in the market and in the processing room and outlines the changes which are taking place, quickly or slowly, in the UK.

Control of the hygienic production of shellfish is discussed in some detail.

There has been a considerable increase in the freshwater fisheries of the UK, both as fish farms and as hatcheries for the restocking of waters used by anglers. The position of botulism as a theoretical risk from this development is noted and recent work mentioned.

The paper goes on to comment on the developing importance of toxins in fish and discusses those which affect the United Kingdom. The contamination of fish by metals and the structure of the monitoring system in the UK are also considered.

The present situation with regard to the importation of fish from tropical waters is considered; especially products, such as cooked prawns, which are eaten in the UK without further cooking after importation.

Lastly, the author sounds a cautionary note by pointing out the epidemiological situation with regard to food poisoning due to the consumption of fish and also discusses the future needs of the fish industry in regard to hygiene.

## Résumé

La place historique du poisson dans le régime alimentaire Britannique est étudiée ainsi que l'histoire de l'inspection de la pêche et du contrôle de qualité.

La notion traditionnelle de risque d'empoisonnement alimentaire par le poisson est évoquée et il est fait mention des modifications qui ont résulté des recherches modernes et des investigations épidémiologiques. On a esquissé sur les problèmes posés au chercheur dans ce domaine par des organismes microbiens tels que le *Vibrio parahaemolyticus* et l'auteur discute en détail des méthodes de manipulation du poisson en mer, sur les quais, au marché et dans les locaux de préparation et esquisse les changements qui se produisent à plus ou moins brève échéance au Royaume Uni.

Le contrôle de la production de coquillages conformément aux règle d'hygiène est discuté de façon assez détaillée.

Il s'est produit une augmentation considérable au nombre d'établissements de pisciculture en eau douce au Royaume Uni pour le repeuplement des eaux appauvries par les pêcheurs à la ligne. La place du botulisme comme risque théorique de ce développement est notée et un travail récent mentionné.

Puis, dans cet article, est comentée l'importance croissante des toxines qui peuvent être trouvées dans le poisson et se trouvent étudiées cells qui affectent le Royaume Uni. La contamination du poisson par les métaux et la structure du système de surveillance au Royaume Uni sont également prises en considération.

La situation présente, en ce qui concerne l'importation de poisson provenant des eaux tropicales, est examinée, en particulier, les produits tels que les crevettes cuites que l'on mange au Royaume Uni sans autre cuisson après leur importation.

Enfin, l'auteur recommande la prudence en faisant remarquer la situation épidémiologique en ce qui concerne l'empoisonnement alimentaire dû à la consommation de poisson et discute des besoins futurs de l'industrie de la pêche en ce qui concerne l'hygiène.

## Resumen

Se estudia la significación histórica del pescado en la dieta británica y se alude a la historia de su inspección y control de calidad.

Se expone la opinión tradicional sobre el riesgo de intoxicación por pescado, mencionando los cambios resultantes de la investigación epidemiológica moderna. Se describen los problemas que en este campo se plantean organismos como *Vibrio parahaemolyticus;* trata el autor detalladamente los métodos de manejo del pescado en el mar, muelles, mercado y áreas de elaboración, y perfila los cambios que están teniendo lugar, con mayor o menor rapidez, en el Reino Unido.

Se estudia el control de la producción de mariscos en condiciones sanitarias con cierto detalle.

Ha habido un aumento considerable de la industria pesquera de agua dulce en el Reino Unido, tanto en viveros como en piscifactorias, para abastecer las aguas frecuentadas por los pescadores de anzuelo. Se señala la importancia del botulismo como riesgo teórico de este desarrollo y se mencionan los últimos trabajos al respecto.

El documento continua comentando la creciente importancia de las toxinas en el pescado y estudia aquellas que afectan al Reino Unido. Se examinan también la contaminación del pescado por metales y la estructura del sistema de control.

Se tiene en cuenta la situación actual respecto a la importación de pescado de aguas tropicales; especialmente los productos como gambas cocidas, que se consumen en el Reino Unido sin posterior cocción tras la importación.

Por último, el autor da un toque de atención a la situación epidemiológica relacionada con la intoxicación por pescado y trata también de las necesidades futuras de la industria pesquera respecto a la higiene.

## Introduction

As the UK is essentially a group of off-shore islands, it will come as no surprise to you to learn that fish has always formed a major part of the national diet. It has always been freely available near the coasts and relatively freely available at inland markets. Some indication of the historical importance of fish is given by the fact that the Worshipful Company of Fishmongers, one of the twelve great livery companies of the City of London, has had an unbroken existence of more than seven hundred years. This Company was granted its first Royal Charter in 1272 and since then, under a succession of Royal Charters and modern legislation, has been responsible for ensuring the quality of fish sold in and around the City of London. Until recently, some varieties of fish were extremely cheap but, in my lifetime, fish has changed from a cheap staple to an expensive occasional meal.

Traditionally, fish has been regarded as a relatively low-risk foodstuff from the point of view of human disease. On epidemiological grounds this is still so, if one excludes shellfish. There have been no significant outbreaks of food poisoning in this country due to either fresh or frozen fish. The Food Hygiene Reference Laboratory of the Public Health Laboratory Service very seldom receives any fish, once again excluding shellfish (Gilbert, personal communication). The reasons for this include the fact that much of our fish harvest is taken from deep, cold waters where the likely organisms are low-temperature and salt-tolerant spoilage types, rather than those pathogenic to man. Furthermore, with the exception of oysters, no fish is eaten raw in this country. Deep-sea fish are usually eaten well cooked although some, together with some varieties of inshore and freshwater fish, are eaten smoked or pickled. In some instances, as with the redoubtable kipper, the fish is smoked before sale and cooked immediately before eating.

## Shellfish

The situation with shellfish has, until recently, been regarded as satisfactory. It has, of course, been realised for many years that shellfish grown in contaminated waters require special attention. The Public Health (Shellfish) Regulations, 1934 and 1948, lay down a procedure which permits those waters which are a particular risk to be controlled. Under this legislation, any Public Health Officer who becomes aware of food poisoning having been caused by the consumption of shellfish from his area, must report the facts to the responsible local authority who may then decide to initiate an investigation. A detailed survey follows which includes the drainage of the land bordering the suspect waters, the presence or otherwise of sewage outfalls, any nearby housing and the flow of water over the shellfish beds. The full picture is completed by a series of bacteriological tests of the water and specimen shellfish. The results of the investigation are reported to the local authority who may then make an Order but, before it can come into force, public notice must be given and the approval of the appropriate Minister obtained. There is an appeals procedure laid down. If all these hurdles are cleared, the Order will come into force on a certain date after which no shellfish from the 'prescribed area' may be sold without having gone through a processing which will render them safe. In the case of cockles, whelks, shrimps and some mussels, the fish are subjected to high-pressure steam treatment. Oysters and mussels, if the latter are to be sold live, are self-cleansed by being placed in water which has been chlorinated (and de-chlorinated) or treated with ultra-violet irradiation, where they are left for twenty-four hours. The water is then changed and the process repeated. All of these processes are subject to monitoring by random sampling and bacteriological examination. Oysters are graded according to the prevalence of *Escherichia coli* Type 1; Grade I oysters must have less than 5 organisms/ml of tissue. Grade II (suspect) have 6 to 15 organisms/ml while Grade III (unacceptable) have more than 15 organisms/ml.

### Handling fish at UK ports

It may be of interest to give a brief account of the common practice in handling and marketing fish at UK ports and of some of the changes which are taking place. Not all these changes are happening quickly, nor are they happening at all ports, but this is a tough industry where money is short and competition considerable. Furthermore, traditional methods are difficult to eradicate and it would be idle to pretend that those in the industry would welcome changes which would increase their costs while not leading to any increased productivity. However, the improvement in the quality of the product if proper handling techniques are adopted is undeniable and changes are taking place if only slowly. There has been an increase in the number of 'freeze at sea' trawlers working and fish so treated are landed in blocks and taken immediately into cold store. Thereafter, they are mostly thawed out and processed in the same way as chilled or fresh fish; but the freezing does keep the fish temperature down during landing and marketing.

So far as fish not frozen at sea are concerned, gutting and washing takes place immediately after catching and the fish are stored in fish rooms below decks. Physical damage is kept to a minimum by the division of the fish rooms into compartments and shelves, using pound boards. Maintenance at low temperature is achieved by the use of a sufficient quantity of melting ice. This is an adequate hygiene measure provided that enough ice is used and that the fish rooms and pound boards are thoroughly cleaned after every voyage. The latter can be very difficult, particularly if the materials used for lining the bulkheads and sides of the fish rooms are not suitable. Metal such as aluminium alloy or hard, smooth renderings such as fine cement are probably best. These materials can be well cleaned by high pressure hosing followed by the use of a sterilant such as hypochlorite. Pound boards should be made of similar metal and capable of thorough cleaning. Pressure hosing alone is seldom enough to prevent build-up of slime and scales. Scrubbing by hand or machine produces some improvement but may be costly and time consuming. Soaking in detergent/sterilizer followed by hosing is probably the best method. An interesting experiment in the port of Fleetwood has been described (McCulloch, 1972) where pound boards were soaked for one hour in 1% sodium metasilicate followed by high pressure hosing. The visual and bacteriological results following this treatment were most impressive. One thing is certain; poor cleansing of fish rooms always results in poor quality fish being landed. It is pleasing to note that some commercial firms have become interested in this work and that some of the larger trawler firms have developed their own specialized cleaning services.

It is possible, therefore, for the fish to be brought alongside the quay in good condition, but what happens to it over the subsequent few hours is vital. It is unfortunate, to say the least, that sometimes the fish is landed, marketed and processed in a way that is fit for anything but a food (Taylor, personal communication). One wonders what would be the public reaction if meat were handled in that way.

Landing from the trawler is accomplished by a number of methods. Plastic trunks are in use in one port and are apparently very satisfactory being thoroughly cleaned by machine at the end of each day (Manson, personal communication). There may be some discussion on this point and on the construction of kits and boxes as there is no general agreement on the best material to use. Some authorities (Taylor, personal communication), maintain that when boxes are made of aluminium the seams trap fish slime and scales while others (Johnstone, personal communication) consider that plastic is difficult to clean and discolours under refrigeration. However, there is general agreement that the wicker baskets and wooden boxes in common use are quite unsuitable, being impossible to clean adequately, while bucket hoists tend to damage too many of the fish.

Once on the quay, the fish are laid out for marketing in kits or boxes. Even when the correct boxes are used, market hygiene needs careful supervision. The speed of unloading often means that fish are spilled on to the floor. It is realized that hosing of the market floor may make it relatively clean but, before and during the selling, many people walk on the floor and tread in dirt of all sorts. Seagulls are also a considerable problem. This unhygienic handling is further compounded by the traditional method of selling the fish during which both salesman and buyers walk on the open boxes containing the fish. Furthermore, it too often happens that insufficient ice is used at this stage, which results in a rise in the temperature of the fish tissues. Particularly during the summer months, ice in quantity must be used below, between and above the fish or the quality will deteriorate.

After sale, many of the fish are boxed for transport to inland markets. The use of open lorries to move open boxes of fresh fish or blocks of frozen fish should not be permitted. Fish for processing in the port are moved into merchants' premises. Much filleting is still done by hand and the filleting trough is still seen far too often. Filleting should be carried out as a line process on a properly constructed board either under a spray of ice-cold potable water or using frequent washings with the same quality water. A trough of stagnant water containing fish heads, gut, slime, and scales and whole fish, waiting to be filleted, is not satisfactory. Immediately after filleting the fish should be placed in clean boxes in plenty of ice; it may be necessary to separate the fillets from the ice because of possible softening effects. If filleting machines are used, great care is necessary to ensure that they are thoroughly cleaned and sterilized at the end of each day's work.

Transport of the fish away from the ports should be in properly designed, insulated or refrigerated lorries. The fish should be well iced and loaded in metal or plastic boxes. The lorries should be enclosed and the interiors lined with hard, easily cleanable material. Sheet metal is probably the best. Once again, maintenance of a sufficiently low temperature is of great importance and the details of available methods have been described (Nicol, 1969). At the inland markets the same precautions to prevent contamination, cross-infection and rise in temperature with consequent loss of quality must be taken.

I have referred to the use of legislation to control harvesting of shellfish from polluted water. There is, however, the possibility that the viruses of infective hepatitis and epidemic vomiting disease may be spread via the consumption of shellfish and the culpability of mussels in the spread of cholera has been demonstrated all too recently. It may be that the normal process of self-cleansing would eradicate the cholera vibrio but I doubt its efficacy against the viruses. Furthermore, I am sure that many of those present have encountered those frustrating outbreaks of gastro-intestinal upset which, despite purification, follow the eating of raw shellfish. For instance, some oysters, notwithstanding the most careful cleansing, still cause diarrhoea and vomiting in some people. Allergy has been suggested as a cause but this is not always tenable on epidemiological grounds. An unknown virus may be responsible but a recent outbreak of food poisoning led incidentally to the demonstration of *V. parahaemolyticus* in a number of seafoods including Grade I oysters which had satisfied the usual bacteriological tests (Hooper *et al.*, 1974). *V. parahaemolyticus* had been isolated from purified oysters previously (Barrow and Miller, 1972) and these authors have suggested that marine bacteria should be used as an additional indicator of bacterial quality (Barrow and Miller, 1969). It appears that, until some means of excluding pathogenic strains of this vibrio is discovered, the only certain way of avoiding unpleasant consequences is to eschew the consumption of raw shellfish altogether.

## Potential safety hazards

### *Vibrio parahaemolyticus*

Over the past two to three decades, however, work has been published which casts doubt on the previous, possibly complacent, ideas about the safety of fish as a food. In Japan, fish is commonly eaten raw. As a result, any pathogenic bacteria in the fish are not destroyed before consumption. The role of *Vibrio parahaemolyticus* in outbreaks of food poisoning due to the consumption of raw fish has been well demonstrated, but what is the importance of this work to the fish industry in this country?

*V. parahaemolyticus* was thought to be found only in warm inshore waters (Sakazaki, 1972) but more recent work has demonstrated it in colder waters such as those off the north-east and north-west coasts of the USA (Barker, 1974). No *V. parahaemolyticus* is found off Norway (Taylor, personal communication) so our far-water and inshore fisheries in the north are likely to be safe. The inshore fisheries along our more southerly coasts must, however, be suspect, particularly during the summer months (Barrow and Miller, 1972). *V. parahaemolyticus* is destroyed by thorough cooking (Peffers *et al.*, 1973) but is it safe to eat smoked Cornish mackerel without further cooking? The situation is further complicated by the hazy state of our knowledge of the pathogenicity of this organism. It has been shown (Sakazaki *et al.*, 1968) that the feeding of the Kanagawa negative strain of this organism to volunteers does not cause disease; only the Kanagawa positive strain is found in isolates from faecal specimens from patients (Sakazaki, 1972). Therefore, as the great majority of cultures of *V. parahaemolyticus* from marine foods are Kanagawa negative (Sakazaki, 1972; Barrow and Miller, 1972; Hooper *et al.*, 1974, Barker, 1974; Bockemühl and Triemer, 1974), bacteriological monitoring of fish from waters which might support this organism would not seem to be likely to give significant results.

It may be accepted that a very few Kanagawa positive organisms, among a large number of Kanagawa negative, may be capable of selective development in the human gut and so cause food poisoning. Even so, the volume of work needed to monitor fish for that small number of Kanagawa positives would inevitably overload our already fully-stretched bacteriology laboratories. It is, however, certain that outbreaks of food poisoning due to *V. parahaemolyticus* have occurred in this country and one causative food has been found to be shellfish harvested around our coasts (Hooper *et al.*, 1974). It has been further shown that the accepted method of cooking large shellfish, such as crabs, may not be sufficient to kill all the vibrios (Peffers *et al.*, 1973). Intensive surveillance, especially during the summer months, of shellfish cooking and preparation premises, to ensure adequate cooking, adequate precautions against cross-contamination and adequate refrigeration up to the time of consumption, is, in my opinion, totally justifiable even though bacteriological screening of the premises and the food would show no pathogenic organisms.

Perhaps it is as well that such potentially pathogenic organisms are not found in distant-water fish landed at our ports. A survey of current practice before, during and after landing, is not calculated to reassure anyone that whatever contamination may be present will be contained at a minimum level. It appears not to be always recognised that, because fish tissue is a very suitable medium for the growth of organisms (Shewan, 1970), the maintenance of fish at a sufficiently low temperature and the prevention of cross-contamination by scrupulous hygiene in marketing and processing, are of the greatest importance. The avoidance of damage to the fish during handling is also of some importance hygienically but it is of much greater note in its effect on the keeping quality of the fish.

### *Clostridium botulinum*

Another cause of recent concern has been the demonstration, over the past few years, of *Clostridium botulinum* in trout bred in this country, in water and mud from the trout farms, and from lakes and waterways which are commonly used by anglers near two of our great cities.

Trout farming is a rapidly developing industry. Fish are bred to provide food for home consumption and for export, and to supply young fish for the restocking of angling waters. It has, of course, been known for some years that where waters, fresh or salt, are subject to run-off from cultivated land, *Cl. botulinum* may be found in fish and mud from those waters. Botulism has occurred from eating uncooked fish from such waters but also, in Germany, from eating hot smoked trout from a fish farm (Bach *et al.*, 1971). Following that discovery, fish farms in the UK were investigated (Burns and Williams, 1975; Cann *et al.*, 1975) and *Cl. botulinum* was isolated from mud and fish.

Botulism is a rare condition in the UK. The last outbreak was in 1955 and was due to imported pickled fish (Mackay-Scollay, 1958). This, together with the low incidence of type E and the apparent low toxicity of the organisms found (Cann *et al.*, 1975) suggests that, at present, there is little risk to the public health. However, the existence of even a potential risk from such a disastrous organism is not a matter to be lightly dismissed. The problem is highlighted by the discovery that *Cl. botulinum* may be isolated from 50 out of 69 of the lakes and waterways around London and that a similar isolation may be made from four out of seven lakes within two miles of the centre of Edinburgh (Smith and Moryson, 1975). Type E was isolated from ten of the London waters. In view of the ever increasing numbers of people who are taking up trout fishing in these waters and the marketing of 'do-it-yourself' trout smoking outfits, one wonders how long our present happy state with regard to botulism will continue. The situation in fish farms may well improve in response to better management techniques (Huss *et al.*, 1974) but a fine line may have to be drawn between panic-mongering and neglect in any attempt to educate anglers away from consumption of partially-cooked or smoked trout.

### *Ichthyosarcotoxism*

Only one form of intoxication due to the consumption of native fish is important in the UK. Filter-feeding molluscs can concentrate large numbers of dinoflagellate phytoplankton and when, at certain times of the year, a rapid increase in the number of dinoflagellates occurs, the molluscs will concentrate the toxin which is found as part of the normal metabolism in them. As no harm results to the molluscs, consumption of such shellfish can take place without recognition of the toxic condition, particularly as the toxin is heat stable. In May 1968 the largest reported outbreak of such poisoning in the UK took place on the north-east coast of England when 78 people were affected following consumption of local mussels. Since then, monitoring has shown that concentrations above the safety level of 400 units/100g occur annually in the summer months along that coast, the maximum level normally being reached in June (Ayres, 1975; Newman, personal communication). As may be imagined, this finding has had a serious effect on the local mussel trade. However, paralytic shellfish poisoning is still a rare condition in the UK. It is of interest that scombroid poisoning accounts for the greatest worldwide morbidity rate of any single type of ichthyosarcotoxism (Bagnis *et al.*, 1970). In view of the amount of mackerel which is eaten in the UK, some of it not too fresh and some of it only smoked, one wonders why this form of poisoning is not more prevalent here.

### *Heavy metal contamination*

There has been great international concern during the last decade over the quantities of heavy metals found in various foods. Following reports of high mercury levels in canned tuna fish in the USA in 1971, the Minister of Agriculture, Fisheries and Food set up an Interdepartmental Committee to co-ordinate all aspects of the chemical contamination of food. This committee, the Steering Group on Food Surveillance, is particularly concerned with identifying sources of food contamination and with arranging analytical surveys to establish the extent of each problem. It is empowered to take immediate action on urgent problems to ensure that the evidence is available to enable the Minister to take action to reduce any source of contamination.

A number of sub-groups of the Steering Group have been set up and concern themselves with special areas of contamination which require separate and intensive study. One such group is the Working Party on the Monitoring of Foodstuffs for Heavy Metals. So far it has published five reports on the mercury, lead and cadmium content of foods commonly consumed in the UK and organized an assessment of the approximate dietary intake of these heavy metals. The surveys have involved close liaison with Food and Drugs Authorities, Port and Air Health Authorities, Public Analysts, and similar overseas agencies.

In its surveillance programme particular attention has been paid to the extent of contamination of marine fish and shellfish by heavy metals. The first report of the Working Party *A survey of mercury in food* (MAFF, 1971) set a pattern of surveillance which, with slight modifications, has been used throughout.

The programme is based in part on monitoring those species which comprise the most significant proportion of the total landings at individual ports in England and Wales as shown in the Sea Fisheries Statistical Tables; the sampling of a given species is tailored to the quantity landed at the port. In England and Wales approximately 80 per cent of the catch in the past has consisted of the species cod, haddock, plaice and herring.

Since the bulk of fish consumed in this country is caught in middle distant waters where, on the whole, the levels of heavy metals in the individual species have been shown to be very low, the average intake of heavy metals from this fish component of the total diet is also low. This is found even when fish provide the major source of intake of a particular heavy metal contaminant, eg mercury. The average intake of mercury in the UK is less than 70 micrograms per week. (The tolerable intake of mercury is assessed as 300 micrograms per week.)

Nonetheless the surveillance programme has examined in great detail other marine fish and shellfish which have a very low consumption in the UK but which can provide a useful index of the state of the marine environment. Most of the common species of fish and shellfish have been monitored in UK estuaries and coastal waters.

In interpreting this body of information great care has to be exercised. Although shellfish in general have much higher concentrations of heavy metals than marine fish, the range of concentrations found in particular species from different areas is considerable and cannot always be attributed to pollution. High metal levels can occur in sediments from natural weathering and run-off and bivalves in general are extremely efficient concentrators of metals from sea waters. The *survey of cadmium in food* (MAFF, 1973) showed that crabs naturally accumulated high levels of cadmium in their brown meat even when there was no known industrial input. Individual areas of the UK coast have been identified where fish and shellfish can contain higher than usual levels of certain trace metals and these areas are subject to intensive study. In general, however, these areas are not exploited commercially and are monitored for other purposes.

In addition to the above studies, various *ad hoc* programmes are undertaken. One such exercise operated in conjunction with Port Health Authorities is concerned with measuring levels of mercury in a wide variety of imported fish. Unlike some foreign countries, regulations do not exist in this country limiting the maximum mercury content of fish and to ensure that fish unacceptable in the country of origin do not find their way onto the UK market, occasional sampling programmes are undertaken. In addition, work is being undertaken to look at heavy metal levels in fish which have not been commercially exploited to any extent in the UK, yet could feature in future processed fish products.

## Importation of tropical fish

The importation of tropical fish into this country is, with one notable exception, still at a low level and aimed at specialized markets. Sea fish such as snapper (Argentina), bonito, squid and octopus (California and Caribbean), lithrini and pomparno (porgy) (Mediterranean), lan yee and won fah (China), yellow croaker (Caribbean and Australasia), trevallee (New Zealand) and cape hake (South Africa) are imported deep frozen, wrapped and cartoned. The flora of these fish are of the same genera as those from temperate waters but with a higher proportion of mesophilic strains. Deep freezing or even chilling is, therefore, very effective but when spoilage does eventually take place, the same organisms are responsible as with fish from colder waters (WHO, 1974). Intoxication or infection due to the consumption of such fish has not been recorded. However, there has recently been one importation of Japanese fugu fish for use in restaurants. The risk attendent upon eating this fish was considered so great that a very firm stand was taken against it by the local public health departments and it was not all offered for sale.

The one notable exception referred to is the very considerable trade in prawns from the Far East, especially in the cooked, peeled, frozen form. As there are papers later in the week on this trade, I do not propose to dwell on it. From the public health point of view in the UK, the problem with the cooked prawns is that high colony counts are found in many consignments and sometimes faecal coli and pathogens such as salmonellas and *Staphylococcus aureus* are found. *V. parahaemolyticus* has also been found but no agreement has yet been reached on the significance of this. While it has been agreed over a number of years by all concerned that such findings indicate a low standard of hygiene in the handling of the prawns and a potential risk to those eating them (because there is normally no further cooking) it has been difficult to find either a method of sampling the very large consignments or a standard interpretation of the microbiological findings which would satisfy everyone. This has still not been completely achieved but, after many months work, a set of Guidelines has been agreed between the Department of Health and Social Security, the Public Health Laboratory Service, the Association of Sea and Airport Health Authorities and the trade. These Guidelines set out recommended methods of sampling, laboratory investigation, interpretation of results and disposal of the prawns, which may be by unconditional or conditional release, by re-exportation or by seizure or surrender. As I have said, the Guidelines do not yet satisfy everyone but they are a step forward.

## Concluding remarks

Lastly, let me sound a cautionary note. I have criticized some practices in the handling of fish in this country. However, any short-fall in hygiene standards must be seen against the background of the industry as it is today and of our present epidemiological experience. It may appear regrettable that the progressive improvement in standards of hygiene seen in industries handling other foods such as meat has not occurred with fish, but perhaps our legislators have not paid so much attention to this part of our national diet because people at large do not expect such high standards in fish handling as they do with other foods. Also, it is true that very few outbreaks of food poisoning can be traced to fish and not even the imported cooked prawn can be said to have caused many outbreaks. However, much preventive work is based on potential risk rather than on a history of actual disease. It is my opinion that the time has come when the need for legislation should be seriously considered. We are falling behind Scandinavian and Continental countries in fish hygiene. If this country is to hold its place during the great changes which will take place in the fishing and fish farming industries in the near future, we must be more alive to the importance of quality and that means being more alive to the importance of good, sound, hygienic practice.

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## References

**Ayres, P. A.** (1975) Mussel poisoning in Britain with special reference to paralytic shellfish poisoning. *Environ. Health,* July, pp. 261–265.

**Bach, R., Wenzel, S., Müller-Prasuhn, G. & Glasker, M.** (1971) Farmed trout as a carrier of *Clostridium botulinum* and a cause of botulism. III. *Arch. Lebensmittelhyg.*, **22**, 107–112.

**Bagnis, R., Berglund, F., Elias, P. S., van Esch, G. J., Halstead, B. W. & Kohei Kohima** (1970) Problems of toxicants in marine food products. *Bull. World Health Organ.*, **42**, 69–88.

**Barker, W. H.** (1974) *Vibrio parahaemolyticus* outbreaks in the United States. *Lancet,* **i**, 551–554.

**Barrow, G. I. & Miller, D. C.** (1969) Marine bacteria in oysters purified for human consumption. *Lancet,* **ii**, 421–423.

**Barrow, G. I. & Miller, D. C.** (1972) *Vibrio parahaemolyticus:* a potential pathogen from marine sources in Britain. *Lancet,* **i** (7748), 485–486.

**Bockemühl, J., & Triemer, A.** (1974) Ecology and epidemiology of *Vibrio parahaemolyticus* on the coast of Togo. *Bull. World Health Organ.*, **51**, 353–360.

**Burns, G. F. & Williams, H.** (1975) *Clostridium botulinum* in Scottish fish farms and farmed trout. *J. Hyg., Cambridge,* **74**, 1–6.

**Cann, D. C., Taylor, L. Y., & Hobbs, G.** (1975) The incidence of *Clostridium botulinum* in farmed trout raised in Great Britain. *J. Appl. Bacteriol.*, **39**, 331–336.

**Hooper, W. L., Barrow, G. I., & McNab, D. J. N.** (1974) *Vibrio parahaemolyticus* food poisoning in Britain. *Lancet,* **i**, 1100–1102.

**Huss, H. H., Pedersen, A. & Cann, D. C.** (1974) The incidence of *Clostridium botulinum* in Danish trout farms. II. Measures to reduce contamination of the fish. *J. Food Technol.*, **9**, 451–458.

**Mackay-Scollay, E. M.** (1958) Two cases of botulism. *J. Path. Bact.*, **75**, 482–485.

**McCulloch, D. R.** (1972) Hygiene, cleaning and transportation practices in the fishing industry. In: *Proc. Symp. Food Insp.* University of Lancaster, 1970, (ed. E. W. Ward), pp. 30–56. London: Association of Public Health Inspectors, 267 pp.

**MAFF** (1971) A survey of mercury in food. *Working Party on the Monitoring of Foodstuffs for Heavy Metals, First Report,* London: HMSO, 33 pp.

**MAFF** (1973) A survey of Cadmium in food. *Working Party on the Monitoring of Foodstuffs for Heavy Metals, Fourth Report.* London: HMSO, 31 pp.

**Nicol, D. L.** (1969) Road transport of frozen fish. *Torry Advisory Note* No. 8. Aberdeen: Torry Research Station, 5 pp.

**Peffers, A. S. R., Bailey, J., Barrow, G. I. & Hobbs, B. C.** (1973) *Vibrio parahaemolyticus* gastroenteritis and international air travel. *Lancet,* **i**, 143–145.

**Sakazaki, R., Tamura, K., Kato, T., Obara, Y., Yamai, S. & Hobo, K.** (1968) Studies on the enteropathogenic, facultatively halophilic bacteria, *Vibrio parahaemolyticus,* III. Enteropathogenicity. *Jpn. J. Med. Sci. Biol.*, **21**, 325–331.

**Sakazaki, R.** (1972) Recent trends of *Vibrio parahaemolyticus* as a causative agent of food poisoning. In: *The microbiological safety of food,* (eds. Hobbs and Christian). *Proc. 8th Int. Symp. Food Microbiol., Reading, 1972.* London: Academic Press, 487 pp.

**Shewan, J. M.** (1970) Bacteriological standards for fish and fishery products. *Chem. Ind.*, 7th February, pp. 193–199.

**Smith, G. R. & Moryson, C. J.** (1975) *Clostridium botulinum* in the lakes and waterways of London. *J. Hyg., Cambridge,* **75**, 371–379.

**WHO** (1974) Fish and shellfish hygiene. *WHO Technical Report Series* No 550, 62 pp.

# Organization of fish inspection programmes in developing countries

**R. Garm and L. Limpus**
Department of Fisheries, FAO, Rome

## Summary

The paper describes a modern concept of an inspection and quality control programme as applied to the fisheries industry and reviews the requirements for its implementation in developing countries. It presents the programme as a co-operative effort of the industry and the government, where both parties are aiming at the reduction of wastage and increased utilization by controlling spoilage and maintaining quality of fish and fishery products 'at a level that satisfies the customer and that is economical to the producer and seller'. It discusses how such a programme should be introduced, giving a brief account of various stages of development in the organization of the programme and its implementation.

## Résumé

Cet article présente une conception moderne d'un programme d'inspection et de contrôle de qualité appliqué à l'industrie du poisson et passe en revue les besoins pour sa mise en oeuvre dans les pays en voie de développement. Ce programme est présenté comme un effort coopératif de l'industrie et du gouvernement où l'une et l'autre parties visent à la réduction du gaspillage et à un meilleur rendement en réduisant les déchets et en maintenant la qualité du poisson et des produits de la pêche à un niveau qui satisfasse le consommateur et qui soit rentable à la fois pour le producteur et pour le vendeur. Dans cet article on envisage comment un tel programme devrait être mis en oeuvre en donnant un bref aperçu des divers stades de développement dans l'organisation du programme et sa réalisation.

## Resumen

Este artículo describe el concepto moderno de programa de inspección y control de calidad, tal y como se aplica en la industria pesquera, y hace una revisión de los requisitos necesarios para su aplicación en los países en vías de desarrollo. Presenta el programa como un esfuerzo cooperativo entre el gobierno y la industria, en el que ambas partes aspiran a la reducción de las pérdidas y al incremento del producto utilizable, mediante el control del deterioro y el mantenimiento de la calidad del pescado y los productos pesqueros, en un nivel que satisfaga al cliente y sea económico para el productor y el vendedor. Se discute cómo puede introducirse dicho programa, dando breve cuenta de los diversos estadios de desarrollo en la organización del programa y su aplicación.

## Introduction

The concept of fish inspection for the purpose of quality control is relatively new in some developed countries and remains mostly unknown or poorly understood in the developing world. Frequently, it is regarded in complete isolation from subjects such as technology of fishing and processing, technological research, development or expansion of industry, and marketing. It is usually equated with the elaboration of complex chemical and bacteriological standards, police enforcement of acts and regulations, government control of industry or interference with its growth.

## Background situation

During the last few years, there has been a rapid expansion of fisheries and a parallel growth of fish processing industries in the developing countries. These newly emerging national industries have become mostly export orientated since foreign exchange was badly needed to pay off initial investments, provide for running expenditures and to attract new investments for further expansion. This rapid growth of the fish processing industry was not matched by the development of new technology, proper facilities or the availability of trained personnel both at the management and worker levels. As a result, the export of fish and fishery products from these countries has suffered considerable losses in rejections and many governments, in desperation, started to look for an immediate solution to the problem. A sudden need arose for a 'kit' or a 'package deal' type of inspection and quality control programme that can be given on request and applies without delay.

In the absence of readily available information or guidance, the governments, under pressure from their industry, decided to proceed on their own by drafting standards based on buyers specifications and giving them a status of law, adopting acts and regulations from the developed countries and copying their organizational structures and policies of enforcement. Frequently these decisions were taken without realizing that:

(a) A programme used successfully by one country would not necessarily suit the needs of another since countries differ in their problems, financial resources, socio-economic conditions, legal philosophies and systems of government.

(b) There should be a good understanding of the underlying principles, obligations towards the industry and consumer and, at the same time, full appreciation of the costs involved.

(c) In order to have an effective and viable programme, careful evaluation of the country's needs has to be made and the organization of the programme and its objectives should be tailored accordingly.

Experience gained from the developed countries indicates that the implementation of the programme encompasses two distinctive but closely related and mutually dependent activities:

1. Quality control (which could be described as an application of proper technology and good manufacturing practices at every stage of fish catching, handling, processing, distribution and marketing) in order to control spoilage, to protect against contamination and adulteration, and to increase utilization.
2. Inspection, referring to devices or methods (established standards, specifications, testing methodology, etc) used in measuring the effectiveness of quality control procedures and all other activities taken to protect the consumer and facilitate trade.

Both activities could, depending on the character of the industry, be implemented by the industry itself. However, generally an independent outside agency, such as the government, is necessary to maintain objectivity in quality assessment in order to gain the confidence of the buyer and to provide services which the producers otherwise might not be able to afford. With government involvement in inspection, full co-operation and participation of the industry is indispensable to make the programme successful otherwise the whole effort might degenerate into a costly exercise in sample collection, laboratory analysis and issuance of 'sanitary' or 'quality' certificates. Such a policy could seriously affect the well-being of a small operator whose ability to better his operation technologically and hygienically is very limited. On the other hand, a decision of the industry to proceed on its own without any governmental 'interference' might be equally short-sighted, as the most common and generally accepted pattern of fish inspection and quality control seems to develop into other directions. It appears, therefore, that the programme offered for adoption by the developing countries should be based on a co-operative effort of industry and government, where both parties are aiming at the reduction of wastage and increased utilization by controlling spoilage and maintaining quality of fish and fishery products 'at a level that satisfies the customer and that is economical to the producer and seller'.

There are several stages in organizing fish inspection and quality control programmes in a developing country. Firstly, the assessment of country needs and the establishment of priorities; secondly, the planning or 'drafting' of the future programme; and, thirdly, its implementation.

## Assessment of country needs

The assessment should be carried out thoroughly, paying particular attention to the problems encountered by the industry. Any difficulties experienced in marketing the product, nationally or internationally, should be carefully noted. A high ratio of product rejections to the total amount of export and the reasons for rejections, a large number of consumer complaints and their nature, below-average sale prices and a low level of utilization are usually indications of serious problems. Once the problems have been identified the next step is to establish the main factors responsible for their existence. Factors such as character and quality of the raw material, methods of catching and handling of fish on board harvesting vessels, adequacy of manufacturing facilities and availability of clean water for processing, sanitation and ice manufacture should be noted and evaluated. An assessment should also be made of problems connected with storage, distribution and marketing of fish and fishery products. Equally important are the educational level and technical qualifications of the managerial and working staff. Occasionally, cultural, religious and political factors might also play a decisive role.

The assessment of the country's needs should also establish whether there is a food controlling agency in the country, what its activities are in relation to the fishery industry and what sector of the industry comes under its jurisdiction. The existence of various food laws and standards should be noted and their relevance to fish and fishery products should be evaluated by a competent expert. One can hardly over-emphasize the importance to the programme of a well-defined legislation. No food controlling agency could perform satisfactorily without being supported by the law.

From a thorough study of the country's needs, it should be possible to establish the immediate, as well as long-range objectives of the programme and assign the priorities. Although it is essential that the final decisions on objectives and priorities should be based on actual needs of the country, the usual pattern is that the funds are limited and some compromise is to be expected.

## Planning stage

It is at this stage that all the proposals pertaining to the type of programme, its extent, organizational structure, legislative support and funding should be spelt out in detail and submitted to the government for consideration. It is important that the planner should also seek the industry's views and thus gain its confidence and co-operation. As was mentioned before, a programme used successfully in one country would not necessarily suit the needs of another. However, there are common features that, from experience gained in some developed countries, seem to be workable.

To facilitate the discussion, and for the purpose of this paper, let us assume that we are dealing with a country divided into several geographic and administrative regions and the programme model to be considered here should:

(a) Be operated by the government for the benefit of the industry and consumer.
(b) Have the full participation and co-operation of the industry.
(c) Be mandatory.
(d) Organizationally be placed within the ministry (department) responsible for the management of national fisheries (see Figure 1).

The structure of the agency, which will be responsible for the implementation of the programme, should have three main elements, namely:

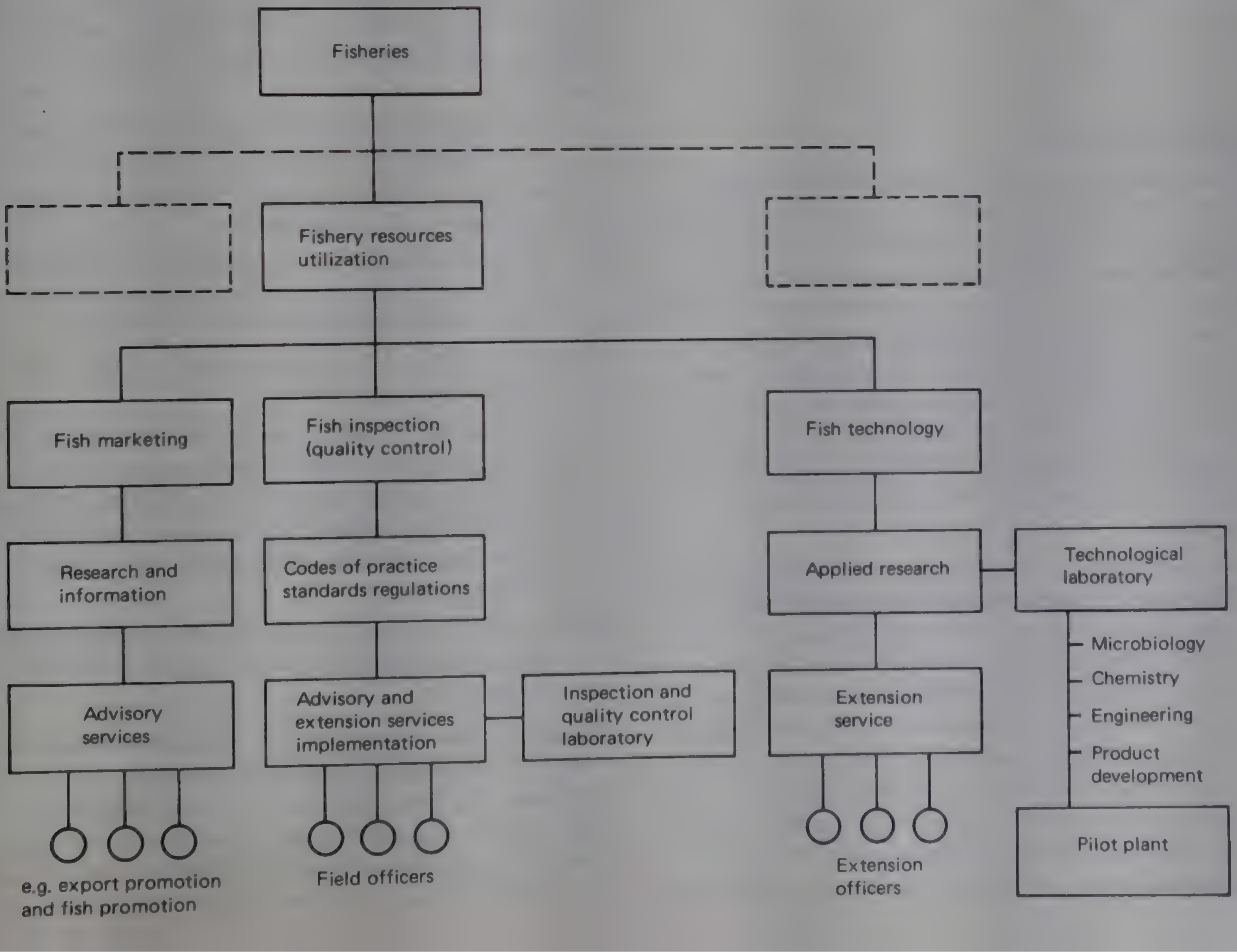
1. National and regional headquarters' management.
2. Supporting laboratories.
3. Field staff (inspection and extension officers).

*Administration:* The administration of the programme at the national headquarters should be field (regional) rather than headquarters orientated. The authority for day-to-day administration should be delegated to the regions where the action takes place and the decisions should be made with a minimum of delay. The responsibilities of the national headquarters should be limited to overall co-ordination, liaison with other departments, research organisations and counterpart agencies of other countries, and evolvement of national policies. The total staff of the national headquarters should be limited to several administrative positions.

It is advisable that the administration of the programme should be independent from the other activities of the ministry, such as resource management and development, technological research, economics, statistics, and marketing, and should be given the same status within the organization as the other services.

*Laboratory services:* Supporting laboratories, which in this case would come under the regions, should be located as close as possible to the industry and should be equipped and staffed to perform organoleptic, chemical and microbiological routine analysis when required. Such laboratories should be divorced from research institutes, hospitals and other food controlling agencies. There has been a tendency, observed in many countries, that such

**Figure 1**
**Suggested organization of fisheries programme**


Fisheries
Fishery resources utilization
Fish marketing
Fish inspection (quality control)
Fish technology
Research and information
Codes of practice standards regulations
Applied research
Technological laboratory
Microbiology
Chemistry
Engineering
Product development
Advisory services
Advisory and extension services implementation
Inspection and quality control laboratory
Extension service
Pilot plant
e.g. export promotion and fish promotion
Field officers
Extension officers

laboratories are increasingly involved in major research activities. Such a policy should be discouraged, especially when there is an established governmental research organization. Only limited applied research investigations should be undertaken providing they are run in co-operation and with the knowledge of a research organization, have direct application to the industry and do not interfere with routine inspection activities. The establishment of a supporting laboratory is usually one of the most costly items in the initial budget of the programme. While the facilities and layout of the laboratory could be planned with provision for a modest expansion, its equipment should reflect only the immediate requirements. Governments should be urged to seek the advice and guidance of competent experts in designing and equipping the fish inspection laboratories.

*Field staff:* Field staff are the working arm of the programme and should be carefully chosen and well trained in order to perform their duties most effectively. Within the modern concept of an inspection and quality control programme, field officers should not only be involved in the enforcement of regulatory requirements but also in helping and guiding the industry in how to meet these requirements and how to reduce wastage and increase utilization. It is important that each officer should have completed at least 'O level' or 'junior high school' and should have had at least 2 months of intensive training in fish processing technology pertinent to his area, with emphasis on hygiene and quality control aspects of fish handling, processing, storage, distribution and sale. He should also be trained in plant and boat inspection, enforcement of regulations, organoleptic assessment of quality and interpretation of laboratory analysis. The candidates should be chosen on their abilities to deal with the public, make decisions, influence and lead.

### *Supporting legislation*

Before drafting a new food law, one should consider carefully the country's political structure, legal philosophy, historical background and connections. Any new law should be framed within provisions permitted by the constitution and must conform to types and styles of general legislation. The presently existing food controlling laws of the country should be taken into account and possibilities of an overlapping authority should be avoided. If this cannot be prevented then a clear line of demarcation within the disputed area should be established or delegation of authority between the agencies might be considered.

Once it is agreed that the existing law of the country is outdated and inadequate for modern needs, and there are provisions in the law for new regulations, then the task of drafting a new law should be carried out by an expert in the field of fish inspection and quality control, and then the final draft submitted to the country's legal authority and the government for consideration. It is important that the industry is consulted during the preparation of the draft so that it is fully aware of how it is going to be regulated and why, and whether it will be able to comply with the law without any deterrent to its future development. In general terms, the new law should:

(a) Protect the consumer against health hazards and fraud.

(b) Provide for fair trade practices in order to protect the industry and trade.

(c) Recognize the influence of the fisherman on quality of landed fish and the importance of proper distribution and retailing practices.

(d) Provide for and define the rights of the inspector (power to enter, search and detain), power to inspect all the imported, exported and local fish and fish products, authority to license plants and fishing vessels.

The law should be elastic in adopting new changes that might arise from specific situations and developments in technology, international standards and market requirements. Inclusion of product standards, tolerances, lists of additives, analytical procedures, sampling schedules, hygienic provisions etc into the body of the basic legislation, should be discouraged as it makes the law voluminous, cumbersome, difficult to follow and less flexible.

### *Funding of the programme*

No planning or 'drafting' of the programme is complete without attempting to estimate its cost and weigh out the possibilities for its funding. Considerable initial expenditures will include the establishment of supporting laboratories and training of staff. For countries with limited financial resources, outside help should be considered. Once the programme becomes operational, the ideal arrangement would be to aim at self-support or, at least, defraying of the major cost of the programme. The running costs could be met by any of the following means:

1. Through general tax revenue (a very sensitive arrangement especially if the industry ranks low in the nation's economy, and highly restrictive to future expansion of the programme).
2. By imposing licence fees on collectors (middlemen), processing boats, processing and storage establishments, distributors, exporters and importers.
3. By imposing a levy on exports and/or imports of fish and fishery products.
4. By charging for sample analysis (such charges should not be made on samples collected under the mandatory requirements) and for any additional services that might be rendered to the industry in applied research investigation, processing trials, product development etc.
5. By sharing some of the costs of the programme with the industry either by a voluntary or compulsory arrangement.

Whichever way of financing the programme is chosen, the final cost of it will pass to the consumer. It is advisable that the provisions for financial support of the programme should be included in the supporting legislation and, if possible, arrangements should be made for budgetary identity of the revenue to be earned.

It should also be mentioned that when a final plan of the programme is ready for submission to the government or an outside financing body, some consideration should be given to the need for funds to assist the industry in complying with the requirements of new regulations and to upgrade its operations.

## Implementation policies

It is important during the initial phase of programme implementation that the industry should be given adequate time (which should be agreed in consultation with the industry) to meet fully the requirements of the law. The following schedule, subject to national and local variations, might be suggested:

– on buildings and heavy equipment – 3 years
– on fishing vessels – 3 years
– on small equipment and utensils – 2 years
– on retailing outlets – 1 year

However, during these periods every processing plant, boat and retailing outlet should be given the right (licence) to operate, providing it complies with the most basic sanitary requirements. In order to commit each operator to a definite plan of improvements, each establishment should provide the government with an annual schedule of work. With regard to the construction of new plants, all the provisions of the law should apply without any deferment. A processor's licence should only be removed or suspended when there is a proved case of serious and flagrant non-compliance with the law.

There will be numerous problems during the working of the programme that will have to be dealt with as policy matters. Those policies which, in our opinion, should be adopted at the initial stage of programme implementation are listed below and are based on practices gained from developed countries.

1. The agency that will be responsible for execution of the programme should not act as referee between the fishermen (seller) and the processing plant (buyer). The processor should face the responsibility and have enough knowledge to decide whether the fish that he is buying is fit for human consumption.
2. The agency should not undertake the marketing of fish and fishery products and should not act as referee between the exporter and buyer.
3. The agency should not enter the development of new products unless it is done jointly with a research organization.
4. Any unused portions of the samples collected by the agency for the purpose of inspection should not be returned to the owner of the lot.
5. Any lost of fish which has been found unfit for human consumption should be destroyed or definite steps should be taken to prevent it from being utilized as human food, unless it could, to the satisfaction of the agency, be reconditioned and made wholesome and fit for human consumption.

The industry should be advised and helped in meeting the regulatory requirements and standards of importing countries. The enforcement of the law should be carried out through education and co-operation. The success of the programme will be measured by a reduced number of rejections and consumer complaints, elimination of wastage, increased utilization and growth of the industry.

# The bacteriology of fresh and spoiling fish and the biochemical changes induced by bacterial action

**J. M. Shewan**
Torry Research Station, UK

## Summary

Although the flesh of newly caught healthy fish is sterile, the skin, gills and, in fish which have recently been feeding, the intestines can carry considerable bacterial loads. All the available evidence appears to show that both quantitatively and qualitatively the microbial flora is a function of the environment in which they are caught. Accordingly the numbers and types of bacteria, particularly on the skin and gills of fish from the northern waters differ, often considerably, from those from tropical or subtropical areas, with psychrophilic types predominating in fish from the colder seas.

The spoilage potential of tropical and subtropical species when stored in ice might thence be expected to differ considerably from those from colder waters and, indeed, many tropical and subtropical species show extensions of shelf life when stored in ice as much as six times those of North Sea fish. However, some tropical fish do spoil as fast as North Sea fish and some of the latter spoil three times as fast as other species from the same area. Possible reasons for these findings are discussed in the light of some recent work on the mechanism of spoilage of marine gadoids from the North Atlantic, and of the role played by specific bacterial species in the spoilage process.

## Résumé

Bien que la chair de poisson sain et fraichement pêché soit stérile, la peau, les branchies, et chez le poisson qui a été nourri récemment, les intestins, peuvent contenir des quantités considérables de bactéries. Tous les faits disponibles semblent indiquer qu'á la fois du point de vue quantitatif et du point de vue qualitatif la flore microbienne est en relation avec le milieu où les poissons se trouvaient lorsqu'ils ont été pêchés. Ainsi, le nombre et le type de bactéries se trouvant en particulier sur la peau et sur les branchies de poisson provenant des mers du nord diffèrent souvent considérablement de ceux trouvés sur les poissons provenant des régions tropicales ou subtropicales avec une prédominance de types psychrophiliques chez les poissons des mers froides.

On pourrait donc s'attendre á ce que les déchets éventuels des espèces tropicales ou subtropicales lorsqu'ils sont gardés dans de la glace diffèrent considérablement de ceux des mers froides et il est vrai que de nombreuses espèces tropicales et subtropicales présentent lorsque'elles sont gardées dans de la glace une durée de conservation six fois plus importante que celle des poissons de la Mer du Nord. Cependant, certains poissons tropicaux se détériorent aussi vite que les poissons de la Mer du Nord et certains de ces derniers se détériorent trois fois plus vite que d'autres espèces provenant de la même région. Les raisons éventuelles de ces constatations sont discutées à la lumière de certains travaux récents sur le mécanisme de détérioration des gadoides marins provenant de l'Atlantique Nord et du rôle joué par les espèces bactériennes spécifiques dans le processus de détérioration.

## Resumen

Aunque la carne del pescado sano recientemente recogido es estéril, la piel, agallas y, en el pescado que se ha alimentado recientemente, los intestinos pueden acarrear una considerable carga bacteriana. La evidencia disponible parece demostrar que tanto cuantitativa como cualitativamente la flora microbiana es función del medio ambiente en que se realiza la pesca. Consiguientemente, el número y los tipos de bacterias, particularmente en la piel y agallas del pescado, procedente de las aguas del norte, difieren, a menudo de un modo considerable de los procedentes de zonas tropicales y subtropicales, con bacterias psicrófilas en los pescados procedentes de mares más frios.

De ello puede inducirse que el potencial de deterioro de las especies tropicales y subtropicales, cuando se conservan en hielo, difiera considerablemente de aquellas que procedan de aguas más frias; en realidad, muchas especies tropicales y subtropicales muestran una vida más larga de almacenamiento cuando han sido conservadas en hielo, hasta seis veces mayor que las de las especies procedentes del Mar del Norte. Sin embargo, algunos pescados tropicales se deterioran tan rápidamente como los del Mar del Norte, y algunos de estos últimos se deterioran tres veces más rápidamente que otras especies procedentes de la misma zona. Se discuten las posibles razones de estos hallazgos a la luz de los trabajos recientes sobre el mecanismo de deterioro de los gadoides marinos procedentes del Atlántico Norte, y del papel que juegan especies bacterianas específicas en el proceso de deterioro.

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## Introduction

In attempting to describe the flora of newly caught fish and of the subsequent changes occurring therein during spoilage, the role of particular bacterial species in the spoilage process and of the biochemical changes involved, one is fully aware firstly that the term 'fish' comprises an extremely wide variety of species both freshwater and marine, from widely differing habitats. Further, that such fish differ both qualitatively and quantitatively, not only in their original microbial floras but also in their chemical and biochemical characteristics. Accordingly, the most that one can hope to do must be somewhat limited and any conclusions one can draw must be tentative. However, within this proviso an attempt has been made to generalize, although lack of data has made this difficult.

## The bacterial flora of newly caught fish

### *Quantitative aspects*

Although the flesh of newly caught healthy fish is sterile, the skin, gills and, in fish which have recently been feeding, the intestines may carry considerable bacterial loads (Table 1). Both quantitatively, and as will be seen below, qualitatively, the flora appears to be a function of the environment. The somewhat higher loads on marine fish from tropical and subtropical areas appear to confirm Kriss' finding (1971) of greater numbers in waters from hotter areas than in the colder regions. More important is the fact that psychrophiles are more abundant in fish from the colder areas than in tropical or subtropical ones. Thus only about 5% of the total flora of fish from the North Sea could grow at 37°C (Shewan, 1944) compared with 55% in fish caught off the Mauritanian coast (Kochanowski and Maciejowska, 1964, 1969).

### *Qualitative aspects*

Qualitatively the flora, particularly of the skin and gills, differs considerably from the varying areas. Thus, Table 2 shows that fish from the northern areas are dominated by the large numbers of psychrophilic gram-negative genera (*Pseudomonas, Alteromonas, Moraxella, Acinetobacter, Flavobacterium/Cytophaga* and *Vibrio*), whereas in fish from warmer waters (Adriatic, S Africa, Indian

TABLE 1. *Bacterial loads on newly caught marine fish*

| *Area* | *Species* | *Temp* | *Skin (per cm$^2$)* | *Gills (per g)* | *Gut contents (per g or cm$^3$)* | *Author* |
|---|---|---|---|---|---|---|
| Temperate Zone | North Sea fish | 20°C | $10^2$–$10^5$ | $10^3$–$10^7$ | $10^3$–$10^8$ | Shewan, 1962 |
| Tropical and subtropical | Indian sardine | 30°C | $10^5$–$10^7$ | $10^6$–$10^8$ | $10^7$–$10^9$ | Karthiayani and Iyer, 1967, 1971 |
| | | 37°C | $10^4$–$10^7$ | $10^8$–$10^9$ | $10^6$–$10^8$ | |
| | Japanese flatfish | 20°C | $10^4$ | $10^3$–$10^5$ | $10^3$–$10^7$ | Simidu *et al.*, 1969 |
| | Australian mullet etc | | $10^4$ | | | Gillespie and MacRae, 1975 |

TABLE 2. *The bacterial flora of the slime of fish (after various authors)*

| *Area* | *Species of fish* | *Gram-negative rods* % | *Coryneforms* % | *Micrococci* % | *Bacilli* % | *Others* % |
|---|---|---|---|---|---|---|
| North Sea | Cod | 88.3 | 8.7 | 1.1 | – | 1.9 |
| | Skate | 81.8 | 3.4 | – | – | 12.8 |
| | Lemon sole | 83.2 | – | – | – | 16.8 |
| | Various species | 88.0 | | 5.6 | 1.6 | 5.0 |
| Norway | Herring | 82.2 | – | 16.7 | – | 1.1 |
| Adriatic | Hake | 43.7 | – | 33.6 | 4.2 | 19.3 |
| Canada | Cod | 86.9 | – | 8.7 | – | 4.4 |
| West Africa | 10 different tropical species | 65.6 | 12.5 | 17.7 | – | 4.2 |
| South Africa | West coast hake | 86.9 | 8.2 | 3.3 | – | 1.6 |
| | East coast hake | 8.4 | 33.3 | 37.5 | – | 20.8 |
| India | Mackerel | 18.3 | – | 27.0 | 50.8 | 3.0 |
| | Sardine | 86.0 | 7.0 | 6.0 | – | – |
| Japan | Flatfish | 66.7 | 29.6 | 3.7 | – | – |
| | | 82.6 | 10.4 | – | – | 6.9 |
| Australia | Elasmobranchs | 11.0 | 61.0 | 17.0 | 2.0 | 9.0 |
| | Teleosts | 16.0 | 12.0 | 60.0 | 8.0 | 4.0 |
| | Teleosts (4 species) | 35.0 | 12.0 | 51.0 | 2.0 | – |

Ocean, Pacific and Australian) the more mesophilic gram-positive genera such as the *Micrococcus*, coryneforms and *Bacillus* seem to predominate. However, in some fish from tropical and subtropical areas the gram-negative genera already mentioned form the bulk of the flora. It seems almost certain, however, that the species within the genera differ and this is exemplified in the data from fish caught off the Florida coast and those caught off Aberdeen (Shewan, 1966a) (Figure 1). Here, although the percentages of the gram-negative bacteria are roughly comparable, the species isolated were quite different eg yellow pigmented *Pseudomonas* species was frequently encountered in Florida fish but has not yet been encountered in North Sea fish.

Where there are data comparing the flora of the sea water with that of the fish caught therein, the correlation can be quite striking (Figure 2): compare for example the North Sea (Shewan, 1962), Indian (Venkataraman and Sreenivasan, 1952, 1954, 1955) and Australia (Wood, 1940, 1953) samples. Several other additional facts support the view that the floras of the gills and skin are directly related to the environment:

1. The micro-organism *Vibrio parahaemolyticus*, which is the cause of more than 40% of the incidents of food poisoning in Japan (Shewan, 1970; Okabe, 1974), appears to be a normal component of the flora of both water and fish in these Far Eastern areas (Velimirovic, 1972) (Table 3). It rarely occurs in the North Sea although it has been found in the sea muds, crabs and shellfish off SW England (Cann, personnal communication) and it can occur in the Baltic (Leistner and Heckelmann 1974) (Tables 4 and 5), Adriatic, Mediterranean and Indian Oceans and off the east and west coast of North America (Liston and Baross, 1973).

**Figure 1**
**Comparison of microfloras of Florida and North Sea fish**

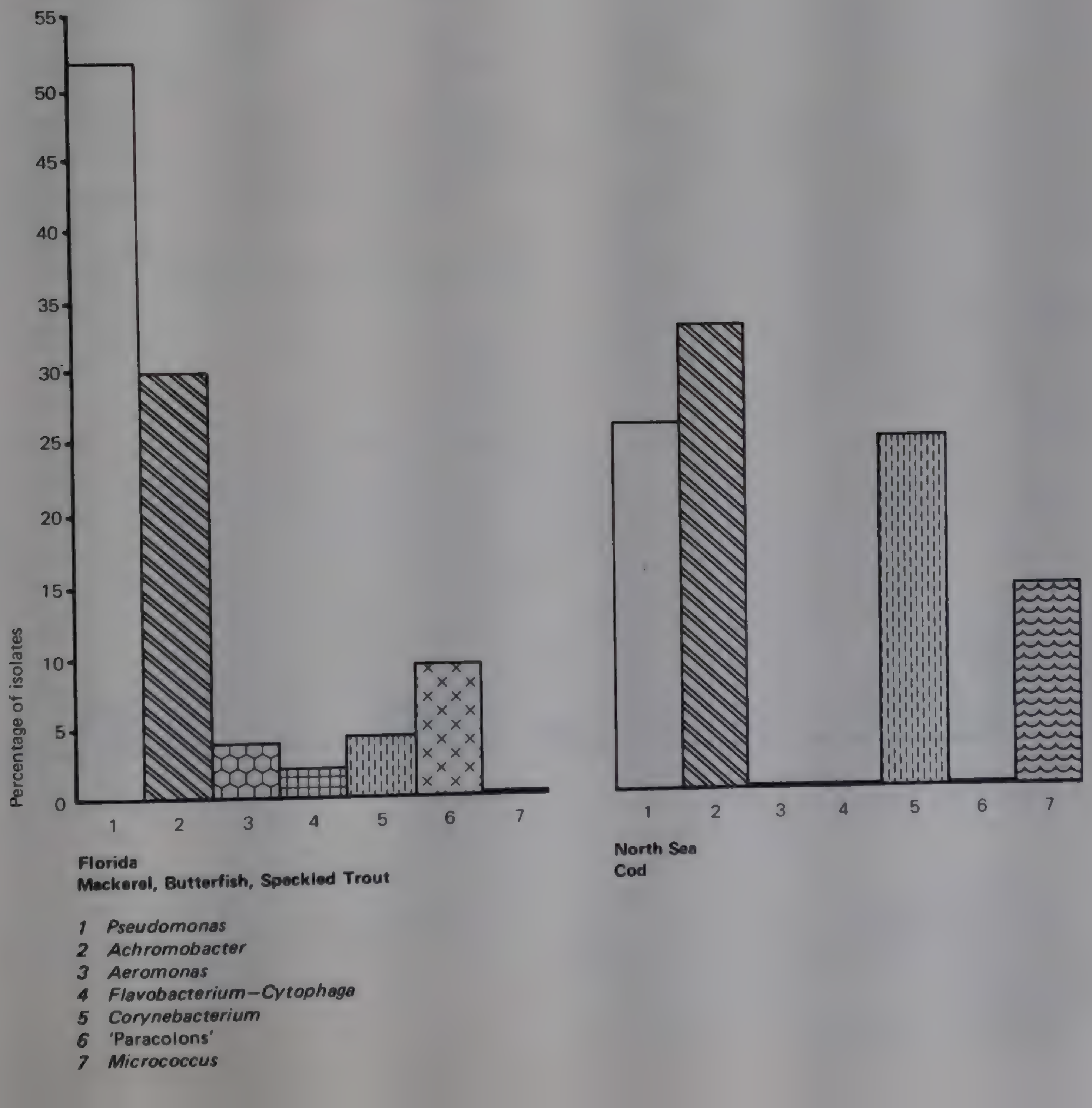
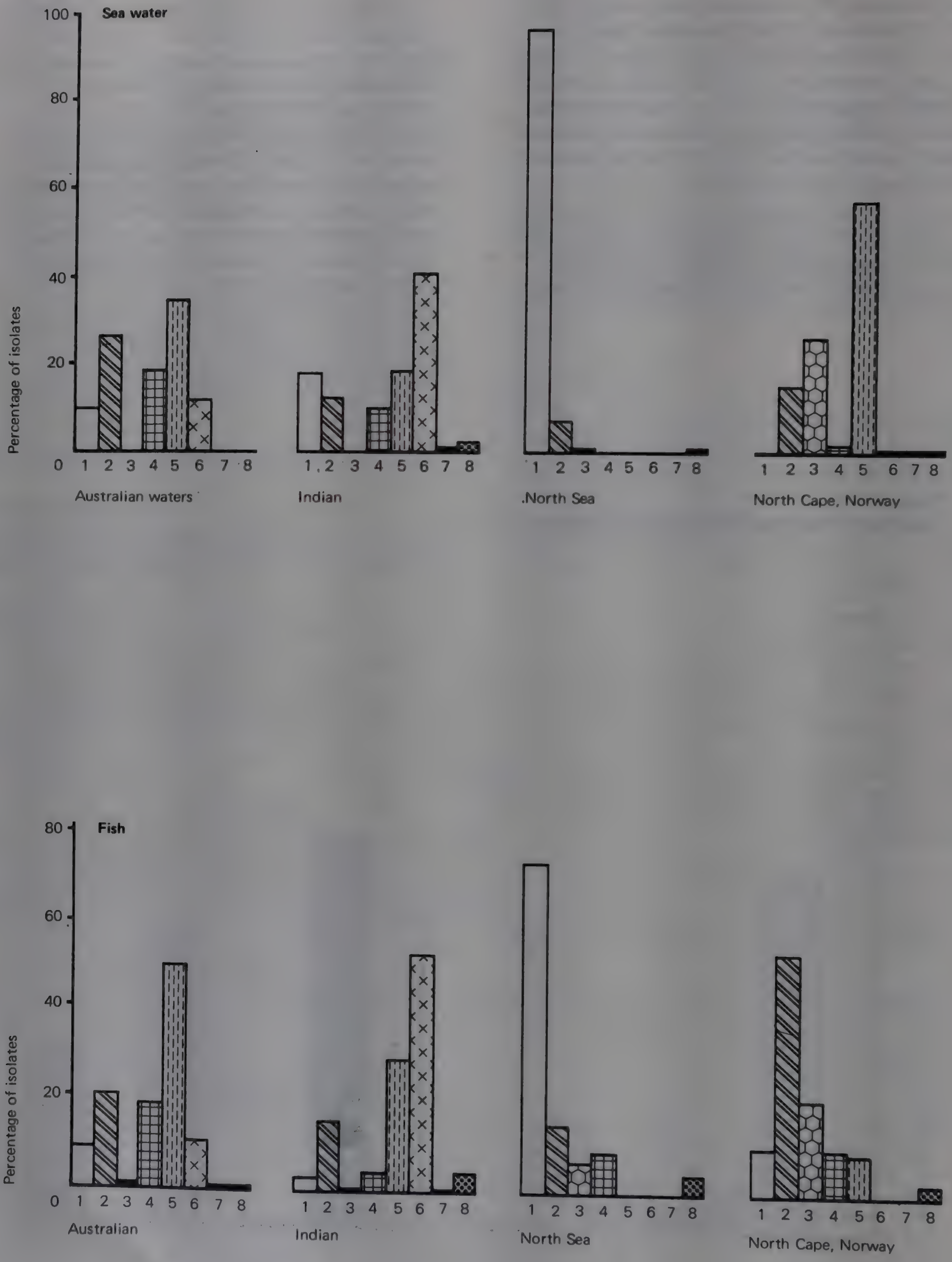


**Figure 2**
Comparison of floras of sea water and sea fish



*1* *Pseudomonas*
*2* *Achromobacter*
*3* *Corynebacterium*
*4* *Flavobacterium*
*5* *Micrococcus*
*6* *Bacillus*
*7* Vibrios
*8* Miscellaneous

TABLE 3. *Incidence of* Vibrio parahaemolyticus *(after various authors)*

| *Area* | *Sample* | |
|---|---|---|
| USA west coast | Sea water | 106 (59)* |
| | Sediments | 25 (23)* |
| | Fish | 170 (90)* |
| | Oysters | 61 (100)* |
| USA east coast | Sea muds | * |
| | Cooked crabmeat | 60 (56)* |
| SE Asia | Sea water | 1,500 (308)† |
| | Plankton | |
| | Sea muds | |
| | Fish | |
| Europe North Sea | North Sea market fish | 170 (0)† |
| Germany | Baltic Sea | 165 (28)† |
| Netherlands | Retail seafish | 323 (1)† |
| | Retail shellfish | 84 (0)† |

* expressed as percentage of samples
† number of samples positive

TABLE 4. *Occurrence of* Vibrio parahaemolyticus *in the North Sea*

| *Survey number* | *Year and month* | *Material* | *Samples examined* | *Samples positive* |
|---|---|---|---|---|
| 12 | 1967 – August | fish(a) | 90 | 0 |
| 13 | 1967 – December | fish(a) | 80 | 0 |
| 14 | 1968 – June/September | fish(a) | 236 | 1 (0.4%) |
| 15 | 1969 – July/August | fish(b) | 200 | 0 |
| 16 | 1969 – August | water(c,d) | 5 | 4 (80%) |
| 17 | 1970 – August | water(d) | 20 | 6 (30%) |

(a) West-Bank, Dogger Bank, Jutland, Helgoland, Iceland
(b) Includes crabs
(c) From Germany (Bremerhaven)
(d) From Denmark (Hanstholm, Tisted, Sennels, Alborg, Esbjerg)

TABLE 5. *Occurrence of* Vibrio parahaemolyticus *in the Baltic Sea*

| *Survey number* | *Year and month* | *Material* | *Samples examined* | *Samples positive* |
|---|---|---|---|---|
| 1 | 1967 – August | fish(a) | 5 | 5 (100%) |
| 2 | 1967 – August | fish(a) | 46 | 25 (54%) |
| 3 | 1967 – December | fish(a) | 80 | 2 (3%) |
| 4 | 1969 – June | fish(b) | 356 | 0 |
| 5 | 1969 – June | water(c,b) | 107 | 0 |
| 6 | 1969 – July/August | fish(a,e,d) | 310 | 242 (78%) |
| 7 | 1969 – July/August | water(a,e) | 62 | 46 (74%) |
| 8 | 1970 – May/June | fish(f) | 19 | 0 |
| 9 | 1970 – August | fish(f) | 96 | 63 (66%) |
| 10 | 1970 – August | brines(f) | 7 | 0 |
| 11 | 1970 – August | water(a,e) | 45 | 22 (49%) |

(a) From Germany – coastal waters
(b) Different areas of the Baltic Sea surveyed with the research vessel FFS Anton Dohrn
(c) Includes plankton and sea mud
(d) Includes crabs and mussels
(e) From Denmark
(f) From Germany

TABLE 6. *Some reported examples of fish borne diseases from polluted waters*

| *Micro-organism* | *Fish incriminated* | *Author* |
|---|---|---|
| *Salmonella* spp. | River eel | Van den Broek, 1948 |
| *Salmonella* spp. | River plate fish | Leiguarda *et al.*, 1950 |
| *Vibrio cholerae* | Hilsa sp. Bengal | Pandit and Hora, 1951 |
| *Salmonella* and *Shigella* spp. | River Nile fish | Floyd and Jones, 1954 |
| *Salmonella* spp. | Marine fish, Ceylon | Gulasekharam *et al*, 1956 |
| *Salmonella* spp. | Central African lake fish | Jadin *et al.*, 1957 |
| *Salmonella* spp. | River fish, Canada | Gangarosa *et al.*, 1968 |
| *Salmonella* spp. | German coastal flatfish | Wuthe and Findel, 1972 |

2. *Clostridium botulinum*, particularly the psychrophilic types E, F and non-proteolytic B, seems to be confined to certain areas (Gordon and Murrell, 1967; Hobbs, 1976) (Figure 3). We rarely find it in our marine fish caught off the British coast (Cann *et al.*, 1966, 1968) yet in one survey from Aberdeen to the Norwegian Coast and thence into the Skagerrak and Kattegat the organism was isolated in increasing numbers (Cann *et al.*, 1965). More recently it has been shown that *Cl. botulinum* types E, F and non-proteolytic B can occur much more frequently in farmed freshwater fish such as trout and must be considered as a normal part of the flora albeit in very small numbers (Huss *et al.*, 1974; Cann *et al.*, 1975).

3. Fish from polluted waters have frequently been incriminated in food poisoning outbreaks and some examples are listed in Table 6. It might be argued that the effect on the flora of the environment on the flora of the fish is due more to the different species of fish used than directly to the water. However, as Table 2 shows, the flora of widely differing species of fish such as cod, haddock, plaice, skate and herring from the North Sea gave almost identical floras. It was, however, possible just recently to compare the flora of one fish species, salmon (*Salmo salar*) in the sea off Aberdeen and when it arrived up the freshwater river, the River Dee, to spawn (Horsley, 1973). Figure 4 shows that although the genera comprising the floras of the sea and fresh water are somewhat alike, there are significant differences, and in particular the presence of the genus *Aeromonas* in both river water and river caught fish and its absence in the marine counterparts. Finally, Kockanowski and Maciejowska (1964, 1969) investigating the flora of the sea and fish off the Mauritanian coast in North Africa constantly encountered the highly coloured red and purple chromobacteria. Such bacteria rarely occur in our cold waters although they do occur in the Mediterranean (Gauthier *et al.*, 1975; Gauthier, 1976).

So far we have been dealing mainly with the flora of the slime and gills. The intestinal flora differs quite considerably from that of the slime and gills. Quantitatively in 'feedy' fish, the numbers are often much greater than in either gills or slime (Table 1). Moreover, qualitatively, the flora is conditioned not so much by the food or

**Figure 3**
**Known incidence of *Cl. botulinum* type E**

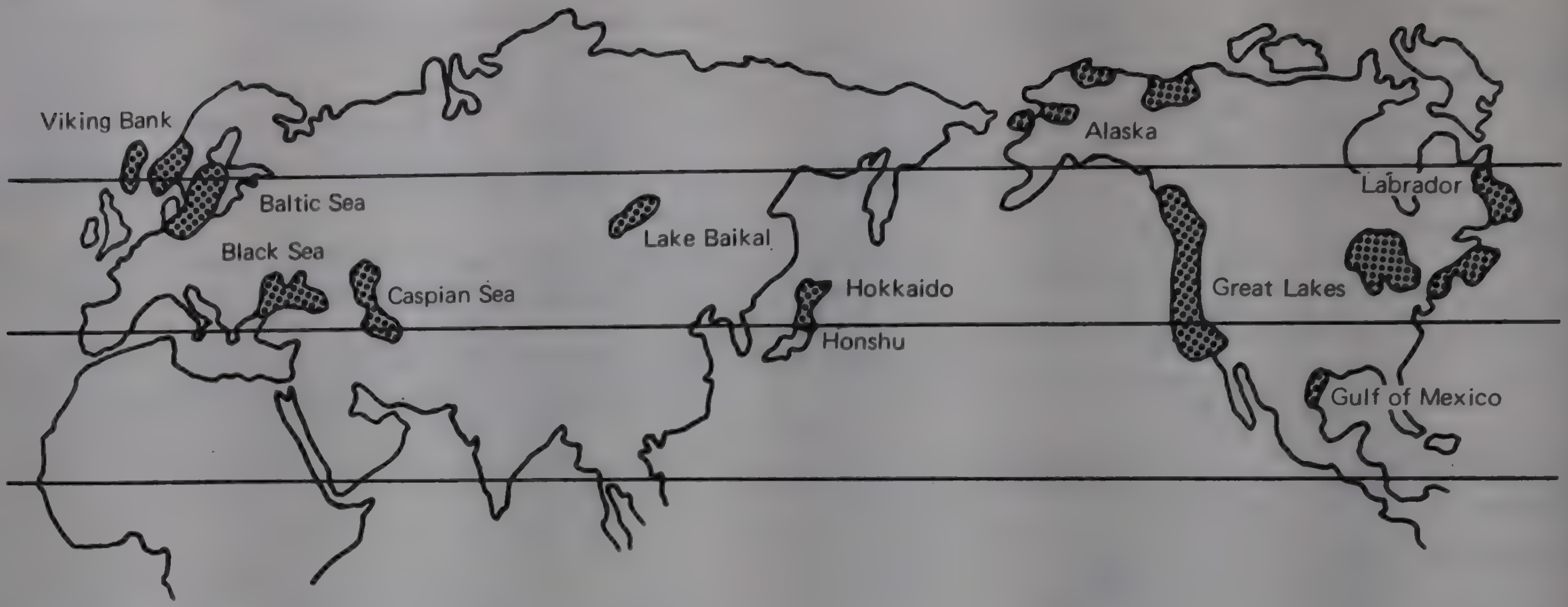

Viking Bank
Baltic Sea
Black Sea
Caspian Sea
Lake Baikal
Hokkaido
Honshu
Alaska
Labrador
Great Lakes
Gulf of Mexico

**Figure 4**
**Comparison of bacteria from sea water and fresh water and fish skin taken from *Salmo salar* in both environments**

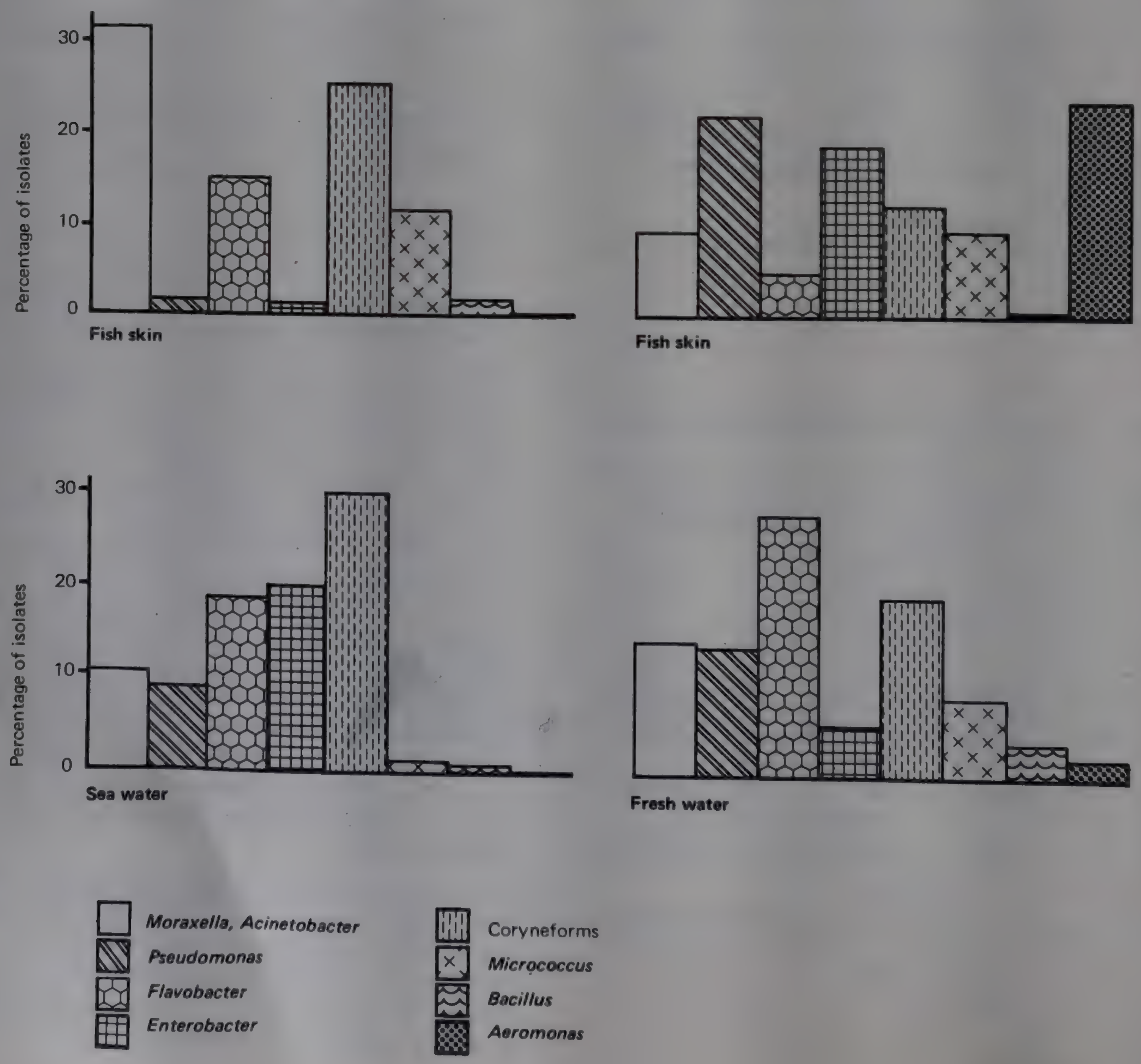


TABLE 7. *Bacterial flora of fresh fish anaerobes (after Shewan, 1962)*

| *Species* | *Sample* | *Anaerobes isolated* | *Author* |
|---|---|---|---|
| Sturgeon and salmon | Flesh | *Cl. botulinum* absent | Van Ermengen |
| Herring | Gills<br>Intestines | Members of the *Clostridium* group isolated | Obst |
| Pacific salmon | Slime | No anaerobes found | Fellers |
| Canadian haddock | Intestines | Members of the *Clostridium* group present | Reed and Spence |
| Sturgeon | Gills<br>Intestines<br>Muscle, etc | Members of *Clostridium* group isolated, eg *Cl. putrificum*, *Cl. botulinum*, etc | Dobrowsky |
| Caspian Sea sturgeon | Intestines | Members of *Clostridium* group isolated eg *Cl. botulinum* | Burova *et al.*<br>Burova and Nasledisheva |
| 'Red fish' – Sea of Azov | ? | *Cl. botulinum* (type E) | Kushnir |
| North Sea haddock | Slime<br>Intestines | No anaerobes found. Members of the *Clostridium* group isolated, eg *Cl. sporogenes*, *Cl. tetani* (types V and X) | Shewan |
| North Sea herring and mackerel | Slime<br>Intestines | No anaerobes found. Members of *Clostridium* group present | Shewan |
| Sander – Sea of Azov | Intestimes | *Cl. botulinum* (type E) | Moreinis |
| Norwegian winter herring | Slime<br>Gills<br>Intestines | No anaerobes found | Aschehoug and Vesterhus |
| Mackerel | Intestine | *Cl. perfringens* | Prevot and Huet |
| Salmon | Intestine | *Cl. botulinum* (type E) | Dolman |

TABLE 8. *Examples of bacterial loads on fresh or newly caught freshwater fish*

| *Area* | *Species* | *Skin (per cm$^2$)* | *Gills (per g)* | *Guts (per g or ml)* | *Author* |
|---|---|---|---|---|---|
| Temperate waters | UK | | | | |
| | Salmon in fresh water | $10^2$–$10^3$ | | $10^1$–$10^2$ | Horsley, 1973 |
| | in the sea | 4.2 x $10^2$ | | $10^3$ | |
| | CANADA | | | | |
| | Salmonids | | | $10^2$–$10^7$<br>over $10^7$ | Trust and Sparrow, 1974 |
| | USA | | | | |
| | 10 species | $10^2$–$10^5$ | | | Potter and Baker, 1961 |
| Tropical and subtropical | BANGLADESH | | | | |
| | Hilsa | $10^3$–$10^4$ | $10^6$ | $10^4$–$10^6$ | Joarder, 1974 |
| | AFRICA | | | | |
| | Kariba | $10^3$–$10^5$<br>over $10^4$ | | | Watanabe, 1971 |
| | TANGANYIKA | $10^3$–$10^5$<br>over $10^3$ | | | Watanabe, 1971 |

TABLE 9. *Shelf life of various species of fish stored in ice*

| *Area* | *Species, marine* | *Shelf life (in days)* | *Author* |
|---|---|---|---|
| Northern temperate | Whiting | 9 | Bramsnaes, 1965 |
| | Cod | 12 | |
| | Haddock | 12 | |
| W Africa | Sea bream | 26 | Amu and Disney, 1973<br>Disney *et al.*, 1973 |
| India | Horse mackerel | 10–45 | Velankar and Kamasastri, 1956 |
| | Bonga | 27 | |
| | Perch | 30–45 | |
| USA | Tuna | 29 | Crawford and Finch, 1968 |

**Figure 5**

**Comparison of bacteria on fish from African lakes, Indian Ocean and the UK**

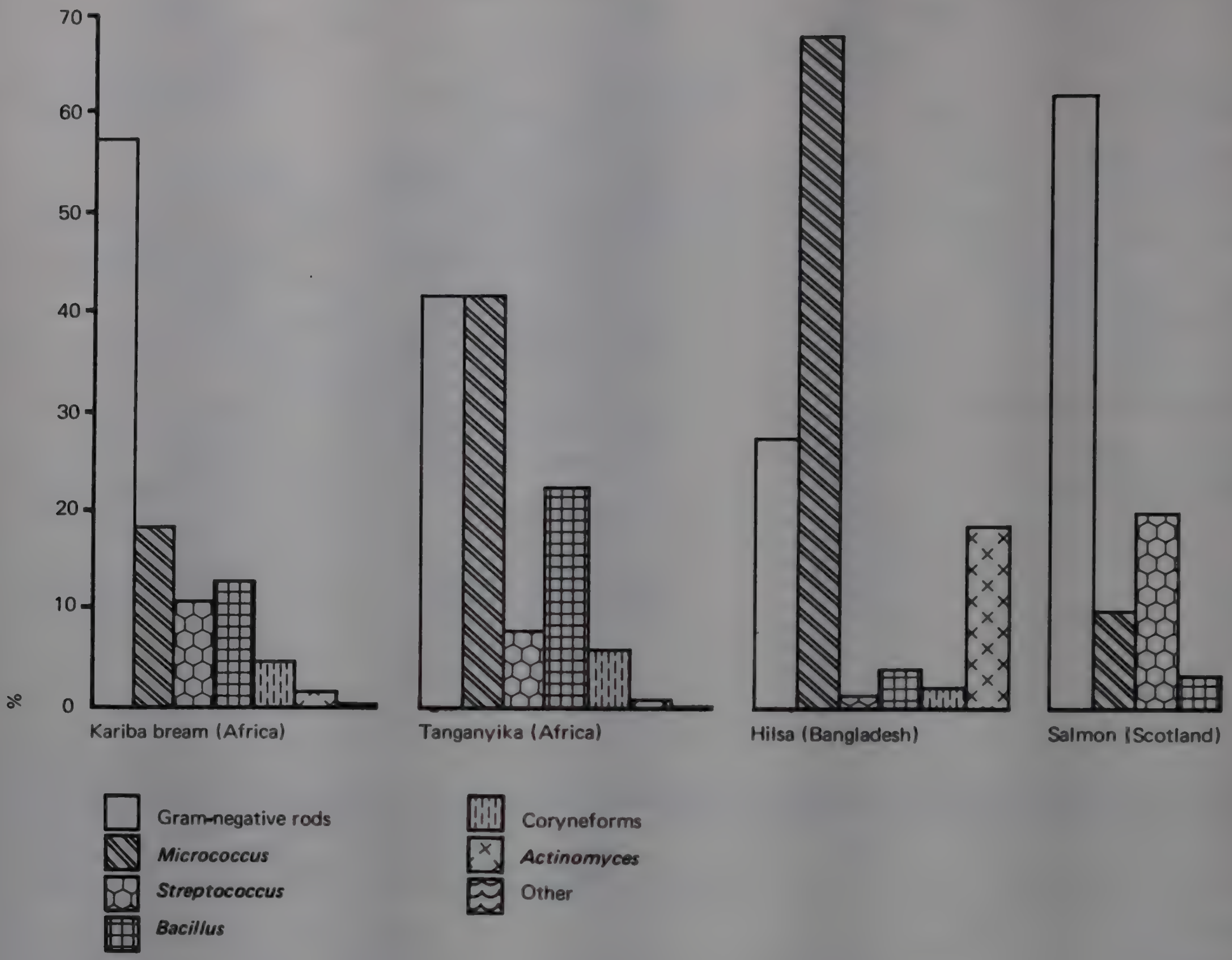
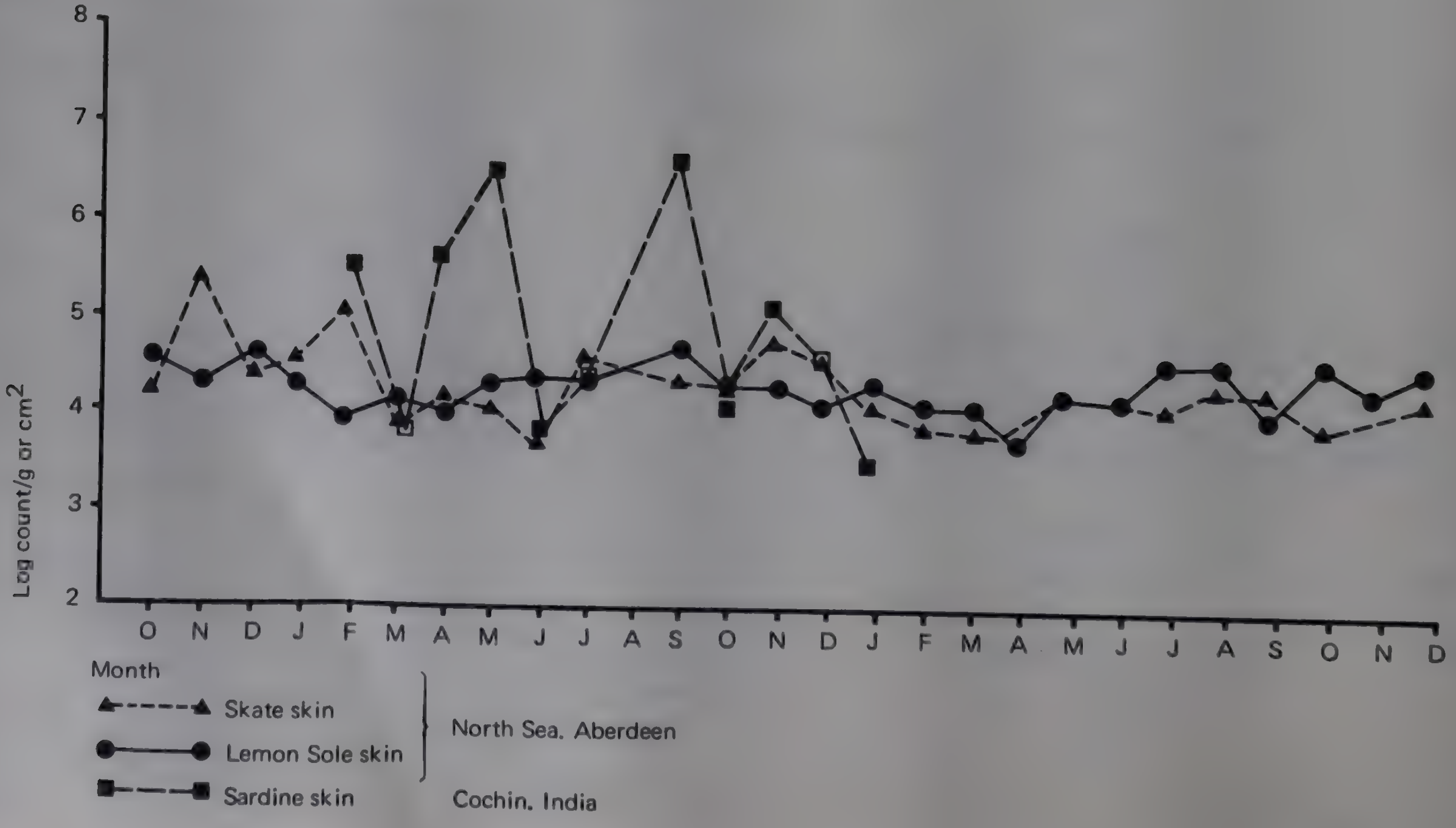


**Figure 6**

**Variations in bacterial loads on fish skin**



external environment as by the special ecological conditions, existing in the stomach and intestines, such as pH, anaerobioses, and presence of bile salts (Sera and Kimata, 1972; Sera, *et al.*, 1974). Accordingly, one might expect a preponderance of facultative and/or strict anaerobes such as *Aeromonas, Vibrio* (Okuzumie and Horie, 1969; Yoshimizu and Kimura, 1976; Yoshimizu *et al.*, 1976) and *Clostridium* species (Shewan, 1962) as compared with the slime and in fact Table 7 appears to bear this out.

### *Freshwater fish*

So far as freshwater fish are concerned data are too few to generalize, the bacterial loads on the skin, gills and intestines are somewhat lower than on marine fish (Table 8) and generally the gram-negative heterotrophs predominate (Figure 5). In the intestines, the *Vibrio* genus does not seem to be as predominant as in marine species.

As a final comment on the floras of fish, it should perhaps be stressed that both qualitatively and quantitatively they are subject to considerable variations depending on such factors as season, method of catching etc (Liston, 1956; Georgala, 1958; Karthiayani and Iyer, 1967, 1971). Figures 6 and 7 show the seasonal variations in the numbers on the skin and intestine of fish from both North Sea and India; trawled fish are known to carry loads 100,000 times greater than line caught fish.

Qualitatively, seasonal variations also occur, since in North Sea fish the more mesophilic gram-positive genera become more abundant in the warm summer months (Shewan, 1966 a and b).

## Spoilage

If, as discussed above, the psychrophiles, which from other work might be expected to be involved in spoilage, form an insignificant part of the floras of tropical and subtropical fish, then such fish, when stored at chill temperatures or in ice (if the latter does not itself carry a significant load of such psychrophiles) should have a considerable extension of shelf life as compared with fish from say the North Sea. As Tables 9 and 10 show, several species of both freshwater and marine fish do have considerably extended shelf lives; compare eg North Sea whiting and Indian perch, where the former stored in ice becomes unacceptable after 9 days and Indian perch after 45 days.

However, other factors are obviously involved because, as Table 10 shows, several species of North Sea fish, such as plaice and halibut, keep three times as long as whiting and some species of tropical fish such as the Indian pomfret or Australian mullet spoil just as quickly as some North Sea fish.

The reasons for the longer shelf life of our flatfish as compared with whiting and haddock has for long been a puzzle and various explanations have been offered such as the low post-mortem pH of the muscle inhibiting bacterial growth, antimicrobial properties of the fish slime and/or flesh, or antagonisms among the organisms themselves. We have recently been looking again at this problem at Torry and in particular at the mechanism(s) of the bacterial attack on fish and the invasion of the flesh. Murray (private communication), who has been mainly responsible for the work, has discovered several important leads. He has concluded that, during spoilage in ice, almost all the bacterial activity is confined to the surface slime and that only late on in the spoilage attack

**Figure 7**
**Variations in bacterial loads on fish guts**

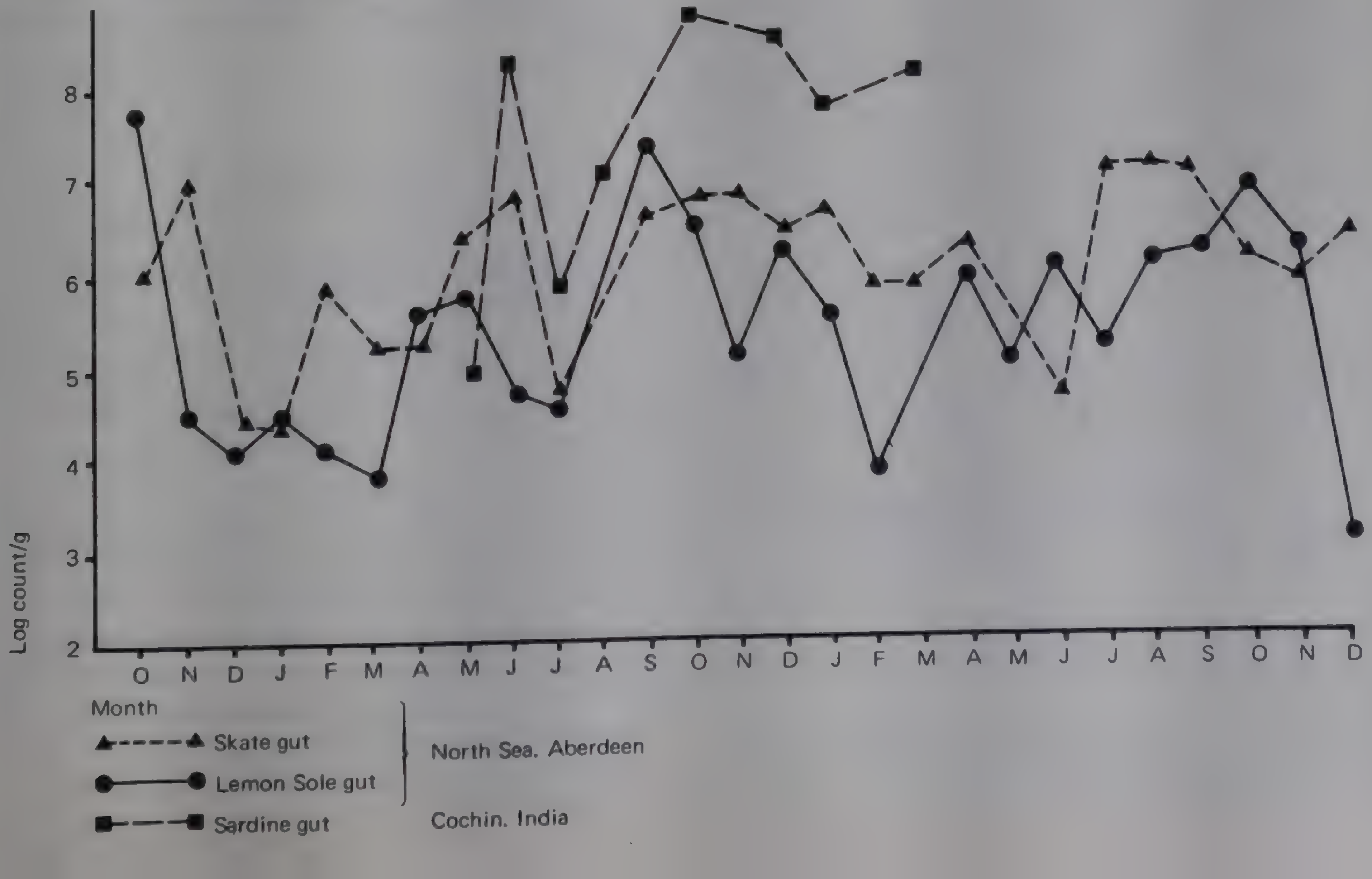


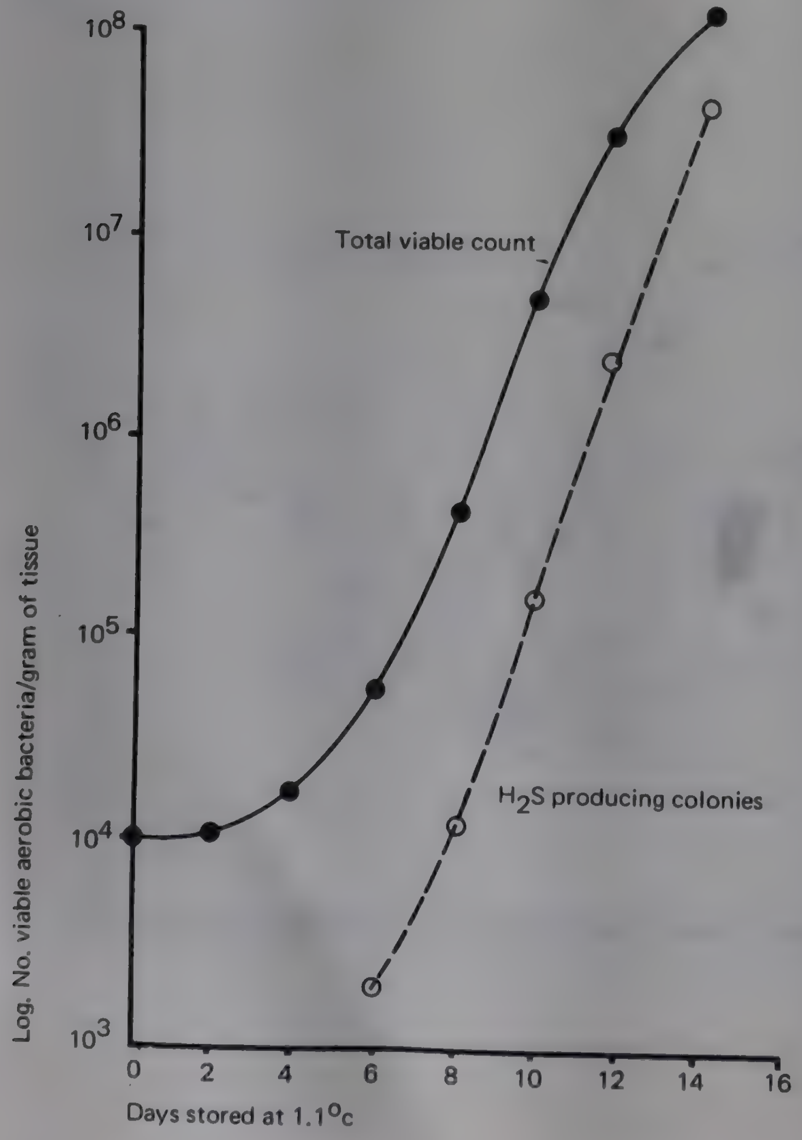
TABLE 10. *Shelf life of varous species of fish stored in ice*

| Area | Species | Shelf life (in days) | Author |
|---|---|---|---|
| Northern temperate | *Marine* | | |
| | Fatty Scotch summer herring | 2–4 | |
| | Lean Norwegian winter herring | 12 | |
| | Mackerel | 6 | |
| | Flatfish | | |
| | Sole, plaice | 17–18 | Bramsnaes, 1965 |
| | Halibut | 21 | |
| | *Freshwater* | | |
| | Perch | 15–17 | Shewan, 1938 |
| | Trout | 9–11 | Niinivaara *et al.*, 1966 |
| E. African | *Freshwater* | | |
| | Kariba bream | 15 | Disney *et al.*, 1969 |
| | Nile perch | 20–28 | |
| | *Tilapia* spp. | 28 | Watanabe, 1965–1966 |
| Indian | *Marine* | | |
| | Pomfret | 7–9 | Kumta and Madhaven, 1973 |
| | Seer | about 9 | Shenoy and James, 1974 |
| | *Freshwater* | | |
| | Mrigal carp | 29 | Nair *et al.*, 1971–74 |

is it possible to demonstrate histologically any significant invasion of the flesh; although at higher temperatures (8°C) such invasion could readily be seen along the collagen fibres.

**Figure 8**

**Total viable counts and number of $H_2S$ producers in stored fish**



Differences in spoilage rates could therefore be attributable to differences in the surface slime. There are few detailed analyses of fish slime although it is known that they are complex mucoproteins, with some free amino acids and sugars and in marine fish some trimethylamine oxide (TMO). However, Murray has shown that flatfish slime contains a relatively high content of lysozyme which is absent in haddock and cod slime, so here may be one important factor influencing spoilage rates. It is of course known that in some species of fish, slime (Liguori *et al.*, 1963) and flesh do contain antimicrobial substances and these may well be operating in the Indian and other species of fish which show extended shelf lives. Another explanation may be the complete absence of the types of bacteria active in spoilage at ice temperatures from slime of these latter fish and hence it is important to know which bacterial species are active in spoilage.

### *Bacterial species active in spoilage*

When fish such as haddock and cod are stored in ice there is, of course after just a day or so, an exponential growth of the bacteria reaching values of $10^8$ to $10^9$/g of flesh or sq cm skin after 8–10 days (Shewan, 1966b; Shewan *et al.*, 1960). This increase is accompanied qualitatively by the emergence of the *Pseudomonas* and *Alteromonas* groups as the predominant genera irrespective of the initial flora of the fish (Table 11) and in particular to the presence of large numbers of hydrogen sulphide producers (Herbert *et al.*, 1971) (Figure 8) such as *Pseudomonas* or more correctly we think, *Alteromonas putrefaciens.* This is almost certainly due to the shorter generation times of these *Pseudomonas* and *Alteromonas* spp. at chill temperatures (Harrison–Church, unpublished data, Torry Research Station, 1973; Morita, 1975) (Tables 12 and 13).

TABLE 11. *Changes in the bacterial floras of fish after storage at chill temperatures*

| *Bacterial types* | | *Days storage* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0(1) | 7 | 0(2) | 8 | *Fresh* (3) | *Spoiled* | 0(4) | 8 |
| *Pseudomonas* | 1 | 20 | 53 | 14 | 3 | 18 | 57 | – | 8 |
| | 2 | | | 14 | 53 | | | 16 | 53 |
| | 3 | | | 3.5 | 31 | | | – | – |
| *Achromobacter* | | 29 | 13 | – | – | – | – | 42 | 25 |
| *Acinetobacter* | | – | – | 32 | 8 | 8 | 26 | – | – |
| *Moraxella* | | – | – | 19 | 3 | 1 | 4 | 2 | 1 |
| *Flavobacter* | | 25 | 1 | 18 | 0 | 8 | – | – | – |
| Coryneforms | | 16 | 2 | – | – | 12 | 1 | 28 | 10 |
| *Micrococcus* | | 1 | – | – | – | 49 | 7 | 10 | 2 |
| *Vibrio* | | 13 | 3 | – | – | – | – | – | – |

(1) Simidu *et al.*, 1969
(2) Lee and Harrison, 1968
(3) Gillespie and McRae, 1975
(4) Shewan *et al.*, 1961

TABLE 12. *Minimum growth temperatures of various species of psychrophiles (after Harrison–Church, unpublished data, Torry Research Station, 1973)*

| *Bacterial strain* | *Origin of species* | *Temperature in °C (after 14 days observation)* |
|---|---|---|
| *Vibrio anguillarum* (NCMB 6) | Ulcerative lesion in plaice | –5 |
| *Pseudomonas fluorescens* (NCMB 129) | Freshly caught cod | –4 |
| *Ps. fragi* (NCMB 320) | Cod in ice for 2 days | –6.5 |
| *Ps. putida* (NCMB 406) | Freshly caught cod | –4.5 |
| *Pseudomonas* sp. (NCMB 1520) | Code in ice for 12 days | –5.0 |
| *'Ps.' putrefaciens* (NCMB 1738) | Unknown | –6.0 |
| *'Ps.' putrefaciens* (NCIB 8615) | Surface tainted butter | –2.0 |
| *'Ps.' rubescens* (NCIB 8768) | Cutting oil | –3.0 |
| *Moraxella* sp. 78 | Spoiling pre-packed cod fillets | –5.0 |

TABLE 13. *Examples of generation time for psychrotrophic bacteria (after Morita, 1975)*

| *Organism* | *Generation time (hours)* |
|---|---|
| *Pseudomonas fluorescens*[a] | 6.68 at 0.5°C<br>30.21 at 0°C |
| *Pseudomonas fluorescens*[b] | 10.65 at 5°C<br>26.41 at 0°C |
| *Pseudomonas* sp. | 2.66 at 10°C<br>10.33 at 0°C |
| Strain 82 (gram-negative, facultative anaerobic rod) | 21.58 at 5°C<br>21.23 at 0°C |
| *Pseudomonas fluorescens*[c] | 4.17 to 8.20 at 4°C |
| *Bacillus psychrophilus* | 6.30 at – 5 to –7°C |
| *Micrococcus cryophilus* | 28.33 at 0°C |
| *Pseudomonas* strain 92 | 11.1 at 2°C |

(a) Inoculum prepared at 20°C.
(b) Inoculum prepared at 5°C.
(c) Generation time depends on type of substrates, stationary or aerated cultures.

Organoleptically there are, of course, considerable changes also taking place during storage in ice which can conveniently be summarized into 4 main phases (Shewan 1974) (Table 14). The latter stages of storage are characterized by the presence of odours such as 'like-onions or leeks', 'meaty', 'sulphidy', 'rotten eggs', 'fruity', 'ammoniacal', 'faecal' etc. The question now is which specific members of the spoilage flora are responsible for producing the organoleptic character of spoiling fish.

Using a technique devised at Torry for obtaining sterile pieces of fish from newly killed animals, it has been possible to test the spoilage potentials of a large number of pure cultures of bacteria isolated from fresh and spoiling fish.

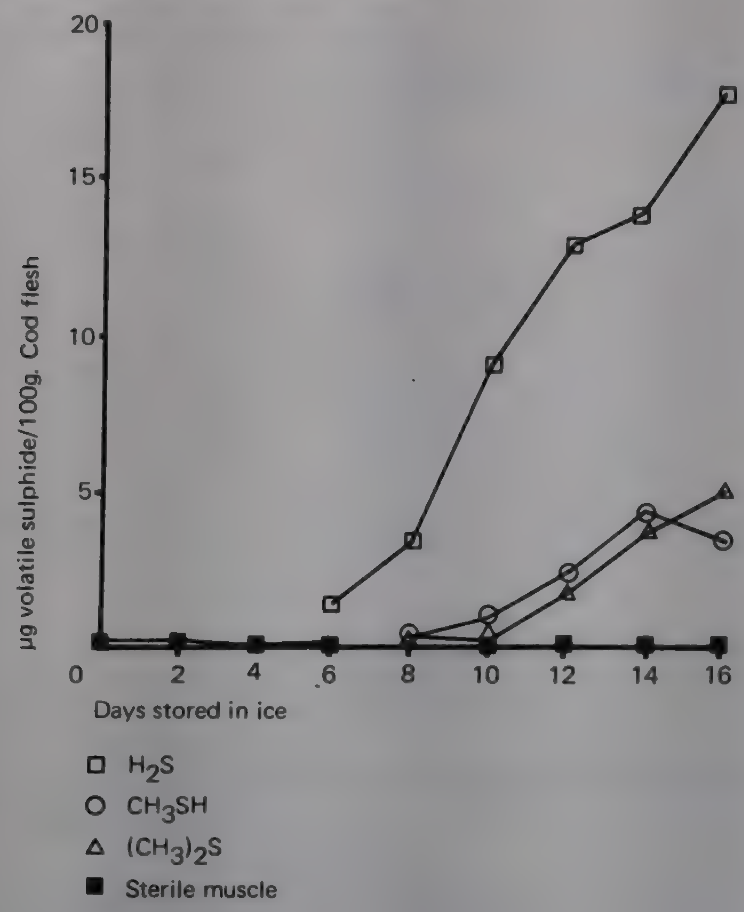
TABLE 14. *Organoleptic changes during storage of white fish at 0°C**

| | |
|---|---|
| Stage I | 0–6 days at 0°C; 0–3 days at 4°C<br>No marked spoilage<br>Firm flesh |
| Stage II | 7–10 days at 0°C; 3–5 days at 4°C<br>Some strengthening of odour, musty, mousey<br>Softer flesh |
| Stage III | 11–14 days at 0°C; 6–7 days at 4°C<br>Some sourness, slight sweet, bready, malty to fruity odour<br>Stale appearance<br>Soft flesh |
| Stage IV | 15 days or more at 0°C; 〉7 days at 4°C<br>$H_2S$ and other sulphidy odours, stale cabbage water, Faecal strong ammoniacal or trimethylamine-like odours<br>Soft slimy flesh |

* At higher temperatures these phases are, of course, speeded up and somewhat telescoped.

**Figure 9**

**Production of $H_2S$, $(CH_3)_2S$, and $CH_3SH$ in naturally spoiling cod fillets and sterile muscle blocks**



Chemical examination of spoiling fish muscle (cod and haddock) has shown that, organoleptically, the most important constituents are the volatile sulphur compounds such as hydrogen sulphide ($H_2S$), dimethyl sulphide ($[CH_3]_2S$) and methyl mercaptan ($CH_3SH$) (Chai *et al.*, 1968; Herbert *et al.*, 1971) (Figure 9) accompanied, when fruity odours are present, by the esters of lower fatty acids such as acetic, butyric, propionic and hexanoic (Castell *et al.*, 1959; Reddy *et al.*, 1969; Miller *et al.*, 1973). The volatile sulphur compounds are produced from the sulphur amino acids, methionine and cysteine (Herbert *et al.*, 1975a; Herbert and Shewan, 1975b) and the esters from the amino acids such as glycine, serine and leucine. None of these compounds is produced in sterile fish muscle although, of course, other considerable changes occur in the muscle post-mortem as a result of tissue enzyme activity, very few of which are important organoleptically. Thus sterile muscle can be kept at 0°C for periods of six weeks or more without any serious organoleptic changes being discerned by a trained taste panel.

The importance of the volatile sulphur compounds can be discerned from Table 15 where it will be seen that threshold values are measured in parts per billion and that the organoleptic characters, odours in particular, change dramatically as the concentrations change (Shewan, 1974). Moreover, the concentrations of these volatile sulphur compounds in spoiling fish muscle are sufficient to account for most of the odoriferous properties of spoiling fish.

Also, when pure cultures of some of these bacteria and in particular *Ps. fluorescens, A. putrefaciens, Ps. fragi* etc are inoculated into sterile pieces of fish, the organoleptic changes produced during storage at 0°C are identical to those present in spoiling fish (Table 16).

One very characteristic odour, sometimes present in spoiling fish, is that of 'old potato sacks' and this has been shown to be produced by a strain of *Ps. fluorescens* – viz *Ps. perolans;* the odoriferous chemical compound being a pyrazine derivative 2 methoxy-3-isopropyl pyrazine (Miller *et al.*, 1973). With marine fish there is also the production of volatile amines such as trimethylamine (TMA) and dimethylamine (DMA) from trimethylamine oxide which contributes to the ammoniacal odours of spoiling fish. The overall qualitative chemical picture of spoiling fish may be summarized as follows (Table 17).

TABLE 15. *Organoleptic descriptions of various concentrations of volatile sulphur compounds (after Herbert, 1970; Guadagni* et al., *1963)*

| *Compound* | *Concentration in ppb in aqueous solution* | *Odour description* | *Concentration produced in naturally spoiling fish muscle after 10 days at 0°C* |
|---|---|---|---|
| $H_2S$ | 20 | No odour | 150 ppb |
| | 40 | Slight $H_2S$ – *threshold value* | |
| | 80 | Medium strong $H_2S$ | |
| | 500 | Strong $H_2S$ | |
| $(CH_3)_2S$ | 0.1 | No odour | 20 ppb |
| | 0.50 | Slightly sour, trace of sulphide – *threshold value* | |
| | 0.75 | Slight cabbage water | |
| | 1.50 | Strong sulphidy, byre like | |
| $CH_3SH$ | 0.01 | No odour | 120 ppb |
| | 0.05 | Very slightly sour – *threshold value* | |
| | 0.10 | Slightly musty and sour | |
| | 0.50 | Slight cabbabe water, leeks | |
| | 2.00 | Sharp strong stale cabbage water | |
| | 100.00 | Metallic, cooked meat, sulphidy | |

TABLE 16. *Organoleptic changes produced in sterile fish muscle, stored at 0 to 2°C, by various pure cultures of bacteria*

| *Strain of micro-organism* | *Origin and author** | | *After about 7 days storage* | *After 14 or more days storage* |
|---|---|---|---|---|
| PSEUDOMONAS GROUP I | | | | |
| *(Ps. fluorescens)* | | | | |
| NCMB 129 | Fish | | Slightly sulphidy and $NH_3$ | Strong $NH_3$, sour sink, putrid $NH_3$ and strong sulphidy |
| NCMB 1792 | Fish | Herbert, 1970 | | |
| NCMB 1355 | Fish | Castell *et al.*, 1957 | | |
| NCMB 1353 | Fish | Castell *et al.*, 1957 | $NH_3$,$H_2S$ turnipy | $H_2S$ sour, sweaty, |
| NCIB 10752 | Chicken | Barnes and Melton, 1971 | | Fruity |
| NCIB 10733 | Milk | Kielwein, 1971 | Fruity | Fishy and sour |
| PSEUDOMONAS GROUP II | | | | |
| *(Ps. fragi)* | | | | |
| NCIB 10723 | Milk | Kielwein, 1971 | Fruity | Fruity |
| NCIB 1789 | Fish | | Fruity | Fruity |
| MJT/F5/102 | Chicken | Barnes and Thornley, 1966 | Fruity | Fruity |
| NCIB 10475 | Homogenised milk | Reddy *et al.*, 1968 | Fruity | Fruity |
| NCIB 10476 | Cottage cheese | Reddy *et al.*, 1968 | Fruity | Fruity |
| | Fish | Florin, 1971 | Fruity | Strong fruity and strong proteolysis |
| PSEUDOMONAS GROUP II | | | | |
| NCIB 10757 | Chicken | Barnes and Melton, 1971 | Very slightly fruity | Fruity |
| NCIB 10725 | Milk | Kielwein, 1971 | Very slightly fruity | Fishy, sour |
| PSEUDOMONAS GROUP IV | | | | |
| *(Ps. putrefaciens)* | | | | |
| NCIB 10471 | Butter | Derby and Hammer, 1931 | Slightly sweaty | Sweaty and sour |
| NCMB 1735 | Stale haddock | Chai *et al.*, 1968 | | Strong sulphidy, stale vegetables $NH_3$ and TMA |
| T12 | Iced cod | van Spreekens† | | Strong, stale vegetables, sulphidy |
| NCIB 10761 | Poultry | Barnes and Melton, 1971 | Faecal | Putrid, $H_2S$, $NH_3$ and TMA |
| *Moraxella* No 78 | Cod fillets | van Spreekens † | No change | No change – strong proteolysis |
| Control | | | No change | No change |

* For references see Shewan, 1974

† Personal communication

TABLE 17. *Tentative scheme of the chemical changes occurring during spoilage of fish*

| *Substrate* | *Compound produced by bacterial action* |
|---|---|
| Inosine | Hypoxanthine |
| Carbohydrates and lactate | Acetic acid, $CO_2$ and $H_2O$ |
| Methionine and cyst(e)ine | Hydrogen sulphide, methyl mercaptan and dimethyl sulphide |
| Glycine<br>Leucine<br>Serine | Esters of acetic, propionic, butyric and hexanoic acids |
| Trimethylamine oxide | Trimethylamine |
| Urea | Ammonia |

By the time bacteria become active, after about the sixth day of storage in ice, the substrate consists of nucleotides and nucleosides and in particular inosine, and some hypoxanthine, ribose, lactate, free amino acids and trimethylamine oxide.

Lactate and the carbohydrates are metabolized to give acetate, $CO_2$ and $H_2O$; inosine is further degraded to hypoxanthine; TMO to TMA and the sulphur amino acids methionine and cysteine to $H_2S$, $CH_3SH$ and $(CH_3)_2S$; and the fruity odours from amino acids such as glycine, leucine and serine. Some of the spoilage bacteria are proteolytic and undoubtedly also contribute to the ammoniacal odours by producing ammonia from the protein breakdown, although proteolysis is not a prerequisite of spoilage (Partmann, 1966; Davey and Gilbert, 1966; Lerke *et al.*, 1967; Shewan, 1974).

## References

**Amu, L. & Disney, J. G.** (1973) Quality changes in West African marine fish during iced storage. *Trop. Sci.*, **15**, 125–138.

**Bramsnaes, F.** (1965) Handling of Fresh Fish. In *Fish as food* (ed. G. Borgstrom), Vol. IV, pp. 1–63. New York: Academic Press.

**Cann, D. C., Wilson, B. B., Hobbs, G., Shewan, J. M. & Johansen, A.** (1965) The incidence of *Clostridium botulinum* type E in fish and bottom deposits in the North Sea and off the coast of Scandinavia. *J. Appl. Bacteriol.*, **28**, 426–430.

**Cann, D. C., Wilson, B. B., Shewan, J. M. & Hobbs, G.** (1966) Incidence of *Clostridium botulinum* type E in fish products in the United Kingdom. *Nature* (London), **261**, 205–206.

**Cann, D. C., Hobbs, G. & Wilson, B. B.** (1968) The incidence of *Clostridium botulinum* in bottom deposits in British coastal waters. *J. Appl. Bacteriol.* **31**, 511–514.

**Cann, D. C., Taylor, L. Y. & Hobbs, G.** (1975) The incidence of *Clostridium botulinum* in farmed trout raised in Great Britain. *J. Appl. Bacteriol.*, **39**, 331–336.

**Castell, C. H., Greenough, M. F. & Dale, J.** (1959) The action of *Pseudomonas* on fish muscle. III. Identification of organisms producing fruity and oniony odours. *J. Fish Res. Board Canada,* **16**, 13–19.

**Chai, T., Chen, C., Rosen, A. & Levin, R. E.** (1968) Detection and incidence of specific species of spoilage bacteria on fish. II. Relative incidence of *Pseudomonas putrefaciens* and fluorescent pseudomonads on haddock fillets. *Appl. Microbiol.*, **16**, 1738–1741.

**Crawford, L. & Finch, R.** (1968) Quality changes in albacore tuna during storage on ice and in refrigerated sea water. *Food Technol.*, **22**, 1289–1292.

**Davey, C. L., Gilbert, K. V.** (1966) Studies in meat tenderness II. Proteolysis and the ageing of beef. *J. Food Sci.* **31** (2), 135–140.

**Disney, J. G., Cameron, J. D., Hoffman, A. & Jones, N. R.** (1969) Quality assessment in *Tilapia* species. In *Fish inspection and quality control* (ed. R. Kreuzer), pp. 71–72. London: Fishing News (Books) Ltd.

**Disney, J. G., Cole, R. C. & Jones, N. R.** (1975) Considerations in the use of tropical fish species. In *Fishery products* (ed. R. Kreuzer). *Proc. Tech. Conf. Fish. Prod., Tokyo, 1973,* pp. 329–337. Surrey, England: Fishing News (Books), 462 pp.

**Floyd, T. M. & Jones, G. B.** (1954) Isolation of shigella and salmonella organisms from Nile fish. *Am. J. Trop. Med.*, **3**, 475–479.

**Gangarosa, F. J., Bisno, N. L., Eichner, E. R., Treger, M. D., Goldfield, M., Dewitt, W. E., Fodor, T., Fish, S. M., Dougherty, W. J., Murphy, J. B., Feldman, J. & Vogel, H.** (1968) Epidemic of febrile gastro-enteritis due to *Salmonella java* traced to smoked fish. *Am. J. Public Health,* **58**, 114–121.

**Gauthier, M. J., Shewan, J. M., Gibson, D. M. & Lee, J. V.** (1975) Taxonomic position and seasonal variations in marine neritic environment of some gram-negative antibiotic producing bacteria. *J. Gen. Microbiol.* **87**, 211–218.

**Gauthier, M. J.** (1976) Morphological, physiological and biochemical characteristics of some violet-pigmented bacteria isolated from sea water. *Can. J. Microbiol.*, **22**, 138–149.

**Georgala, O. L.** (1958) The bacterial flora of the skin of North Sea cod. *J. Gen. Microbiol.*, **18**, 84–91.

**Gillespie, N. C. & Macrae, I. C.** (1975) The bacterial flora of some Queensland fish and its ability to cause spoilage. *J. Appl. Bacteriol.*, **39**, 91–100.

**Gordon, R. A. & Murrell, W. G.** (1967) Botulism. The present situation reviewed. *Food Manuf.* **42**, 34–41.

**Guadagni, D. C., Buttery, R. C. & Okano, S.** (1963) Odour thresholds of some organic compounds associated with food flavours. *J. Sci. Food Agric.*, **14**, 761–765.

**Gulasekharam, J., Velaudapillai, T. & Niles, G. R.** (1956) The isolation of salmonella organisms from fresh fish sold in a Colombo fish market. *J. Hyg., Cambridge,* **54**, 581–584.

**Herbert, R. A.** (1970) *A study of the roles played by bacterial and autolytic enzymes in the production of volatile sulphur compounds in spoiling North Sea cod.* Ph.D. thesis, University of Aberdeen.

**Herbert, R. A., Hendrie, M. S., Gibson, D. M. & Shewan, J. M.** (1971) Bacteria active in the spoilage of certain sea foods. *J. Appl. Bacteriol.*, **34**, 41–50.

**Herbert, R. A., Ellis, J. R. & Shewan, J. M.** (1975a) Isolation and identification of the volatile sulphides produced during chill storage of North Sea cod *(Gadus morhua). J. Sci. Food Agric.*, **26**, 1187–1194.

**Herbert, R. A. & Shewan, J. M.** (1975b) Precursors of the volatile sulphides in spoiling North Sea cod *(Gadus morhua). J. Sci. Food Agric.*, **26**, 1195–1202.

**Hobbs, G.** (1976) *Clostridium botulinum* and its importance in fishery products. *Adv. Food Res.*, **22**, 135–185, New York: Academic Press.

**Horlsey, R. W.** (1973) The bacterial flora of the Atlantic salmon (*Salmo salar* L.) in relation to its environment. *J. Appl. Bacteriol.*, **36**, 377–386.

**Huss, H. H., Pedersen, A. & Cann, D. C.** (1974) The incidence of *Clostridium botulinum* in Danish trout farms. I. Distribution in fish and their environment. *J. Food Technol.*, **9**, 445–451.

**Jadin, J., Resseler, J. & Van Looy, G.** (1957) Presence de *Shigella* et *Salmonella* chez les poissons et dans les eaux des grands lacs du Congo Belge et due Ruanda-Uruindi. *Bull. Acad. R. Méd. Belg.* **22**, 85–96.

**Joarder, G. K.** (1974) Bacteriology of fresh water fish. Part I. Low temperature bacteria in Hilsa fish *(Hilsa ilisa). Bangladesh J. Sci. Ind. Res.*, **9**, 51–60.

**Karthiayani, T. C. & Mahadeva Iyer, K.** (1967) Quantitative and qualitative studies on the bacterial flora of fresh sardines. *Fish. Technol.*, **4**, 89–97.

**Karthiayani, T. C. & Mahadeva Iyer, K.** (1971) Seasonal variations of bacterial flora of fresh oil sardines *(Sardinella longiceps). Fish. Technol.*, **8**, 69–79.

**Kochanowski, J. & Maciejowska, M.** (1964) Bacterial flora of sea fish from West African fishing grounds I. *Prace Morskiego Instytutu Rybackiego* 13 (Ser. B), 93–106.

**Kochanoswki, J. & Maciejowska, M.** (1969) Bacterial flora of sea fish from West African fishing grounds. *Prace Morskiego Instytutu Rybackiego* **14** (Ser. B), 153–167.

**Kriss, A. E.** (1971) Marine microbiology, ecology and geography. *Microbiol.*, **40**(5), 904–911.

**Kumta, U. S. & Madhavan, V. N.** (1973) Radurisation process for Indian salmon *(Eleutheronesma tetradactylum)* and Black Pomfret *(Parastromateus niger) Acta Aliment.*, **2**, 467–475.

**Lee, J. S. & Harrison, J. M.** (1968) Microbial flora of Pacific Hake *(Merluccius productus) Appl. Microbiol.*, **16**, 1937–1938.

**Leiguarda, R. H., Palazzolo, A. Z. R. & Peso, O. A.** (1950) Bacterias del contenido intestinal de algunos peces del Rio de la Plata. *Revista obras sanitaire nacionale* (Buenos Aires), **14**, 2–8.

**Leistner, L. & Heckelmann, H.** (1974) In: *International Symposium on Vibrio parahaemolyticus* (eds T. Fujino, G. Sakaguchi, R. Sakazaki & Y. Takeda) p.83. Tokyo: Saikon Publishing Co.

**Lerke, P., Farber, L. & Adams, R.** (1967) Bacteriology of spoilage of fish muscle. IV Role of protein. *Appl. Microbiol.*, **15**, 770–776.

**Liguori, V. R., Ruggieri, G. D., Baslow, M. H., Stempien, M. F. & Nigrelli, R. F.** (1963) Antibiotic and toxic activity of the mucus of the Pacific striped bass, *Grammistes sexlineatus. Am. Zool.*, **31**, p.546. Abstract No. 302.

**Liston, J.** (1956) Quantitative variation in the bacterial flora of flatfish. *J. Gen. Microbiol.*, **15**, 305–314.

**Liston, J. & Baross, J.** (1973) Distribution of *Vibrio parahaemolyticus* in the natural environment. *J. Milk Food Technol.*, **36**, 113–117.

**Miller, A., Scanlan, R. A., Lee, J. S. & Libbey, L. M.** (1973) Identification of the volatile compounds produced in sterile fish muscle by *Pseudomonas fragi. Appl. Microbiol.*, **25**, 952–955.

**Morita, R.** (1975) Psychrophilic bacteria. *Bacteriol. Rev.* **39**, 144–167.

**Nair, R. B., Tharamani, P. K. & Lahiry, N. L.** (1971–1974) Studies on chilled storage of fresh water fish. I. Changes occurring during iced storage, and II. Factors affecting quality. *J. Food Sci. Technol.*, **8**, 53–56 and **11**, 118–122.

**Niinivaara, F. P., Ritva-Liisa, S. & Laine, J. L.** (1966) Rainbow trout *(Salmo iridens)* produced in Finland. I. Bacterial spoilage and amino acid composition of fresh rainbow trout during refrigerated storage. *Maatalonstieteelinen Aikak.*, **38**, 210–220.

**Okabe, S.** (1974) In: *International Symposium on Vibrio parahaemolyticus* (eds T. Fujino, G. Sakaguchi, R. Sakazaki & Y. Takeda) p.5. Tokyo: Saikon Publishing Co.

**Okuzumi, M. & Horie, S.** (1969) Studies on the bacterial flora in the intestines of various marine fish. *Bull. Jpn. Soc. Sci. Fish.*, **35**, 93–100.

**Pandit, C. G. & Hora, S. L.** (1951) The probable role of the Hilsa fish *Hilsa ilisha* (Ham) in maintaining cholera endemicity in India. *Indian J. Med. Sciences*, **5**, 343–356.

**Partmann, W.** (1966) Untersuchungen zur Beurteilung autolytischer und bakterieller Einflusse auf den Fischverderb. *Z. Lebensm. Unters. Forsch.*, **129**, 205–222.

**Potter, L. F. & Baker, G. E.** (1961) The role of fish as conveyors of microorganisms in aquatic environments. *Can. J. Microbiol.*, **7**, 595–605.

**Reddy, M. C., Bills, D. D., Lindsay, R. C., Libbey, L. M., Miller, A. & Morgan, M. E.** (1968) Ester production by *Pseudomonas fragi.* I. Identification and quantification of some esters produced in milk cultures. *J. Dairy Sci.*, **51**, 656–659.

**Sera, H. & Kimata, M.** (1972) Bacterial flora in the digestive tract of marine fish. I. *Bull. Jpn. Soc. Sci. Fish.*, **38**, 50–55.

**Sera, H., Ishida, Y. & Kadota, M.** (1974) Bacterial flora in the digestive tracts of marine fish. In: *Effect of the Ocean Environment on Microbial Activities* (eds Colwell & Morita) pp 467–490. Baltimore: University Park Press.

**Shenoy, A. V. & James, M. A.** (1974) Spoilage of spotted seer *(Scomberomorous guttatus)* during ice storage. *Fish. Technol.*, **11**, 67–72.

**Shewan, J. M.** (1938) The spoilage of fish. *Report of Director of Food Investigation for the year 1938*, pp. 79–87. London: HMSO.

**Shewan, J. M.** (1944) The bacterial flora of some species of marine fish and its relation to spoilage. *Proc. Soc. Agric. Bacteriol. (Abstracts)*, 1–5.

**Shewan, J. M.** (1961) The microbiology of seawater fish. In *Fish as food* (ed. G. Borgstrom) pp. 487–560. London: Academic Press.

**Shewan, J. M.** (1962) The bacteriology of fresh and spoiling fish and some related chemical changes. In *Recent advances in food science* (eds Hawthorn & Muil Leitch) pp. 167–193. London: Butterworth.

**Shewan, J. M.** (1966a) Some factors affecting the bacterial flora of marine fish. Supplement to *Medlemsblad for Den Norske Veterinaerforening* No. 11, 1–12.

**Shewan, J. M.** (1966b) Bacteriological and biochemical changes occurring during microbial spoilage of fish. Supplement to *Medlemsblad for Den Norske Veterinaerforening* No. 11, 13–20.

**Shewan, J. M.** (1970) Bacteriological standards for fish and fishery products, *Chem. Ind.*, 193–199.

**Shewan, J. M.** (1974) The biodeterioration of certain proteinaceous foodstuffs at chill temperatures. In: *Industrial aspects of biochemistry* (ed. B. Spenser), pp. 475–490. Federation of European Biochemical Societies.

**Shewan, J. M., Hobbs, G. & Hodgkiss, W.** (1961) The *Pseudomonas* and *Achromobacter* groups of bacteria in the spoilage of marine white fish. *J. Appl. Bacteriol.*, **23**, 463–468.

**Simidu, U., Kaneko, E. & Aiso, K.** (1969) Microflora of fresh and stored flatfish, *Kareius bicoloratus. Bull. Jpn. Soc. Sci. Fish.*, **35**, 77–82.

**Trust, T. J. & Sparrow, R. A. H.** (1974) The bacterial flora in the alimentary tract of freshwater salmonid fishes. *Can. J. Microbiol.*, **20**, 1219–1228.

**Van den Broek, C. J. H.** (1948) Onderzoek naar bactericide werkung vannet paling roken. Centraal Institut Voedingsonderzoek. *TNO Utrecht Mededl. Publ.* No. 72.

**Velankar, N. K. & Kamasastri, P. V.** (1956) The bacterial flora, trimethylamine and total volatile nitrogen of fish muscle at 0°C (in ice). *Indian J. Fish.* **3**, 269–289.

**Velimirovic, B.** (1972) The geographical distribution of human disease due to *Vibrio parahaemolyticus* in south east Asia and the Pacific. *Zentralblatt Bakteriologie Hygiene,* 1 Abt. Ref. 227, 385–397.

**Venkataraman, R. & Sreenivasan, A.** (1952) A preliminary investigation of the bacterial flora of the mackerels of the West Coast. *Indian J. Med. Res.*, **40**, 529–533.

**Venkataraman, R. & Sreenivasan, A.** (1954) Bacteriology of off-shore sea water of the West Coast. *Proc. Indian Acad. Sci.*, **40**, 161–166.

**Venkataraman, R. & Sreenivasan, A.** (1955) Bacterial flora of fresh shark. *Curr. Sci.*, **24**, 380–381.

**Watanabe, K.** (1965–66) Handling and keeping quality of iced Kariba Bream *(Tilapia mortimeri)* (Syn *T. mossambica* Peters) *Fish. Res. Bull., Zambia,* **4**, 59–64.

**Watanabe, K.** (1971) Bacteria from fresh fish at landing on Lakes Kariba and Tanganyika. *Fish. Res. Bull., Zambia,* **5**, 187–198.

**Wood, E. J. F.** (1940) Studies on the marketing of fresh fish in Eastern Australia. Commonwealth of Australia. *Counc. Sci. Ind. Res., Div. Fish. Rep. No 3,* 92 pp.

**Wood, E. J. F.** (1953) Heterotrophic bacteria in marine environments of Eastern Australia. *Aust. J. Mar. Freshwater Fish.*, **4**, 160–200.

**Wuthe, H. H. von & Findel, G.** (1972) Salmonellen bei Plattfischen in Kustengewassern. *Arch. Lebensmittelhyg.*, **23**, 110–111.

**Yoshimizu, M. & Kimura, T.** (1976) Study on the intestinal microflora of salmonids. *Fish Pathol.*, **10**, 243–259.

**Yoshimizu, M., Kimura, T. & Sakai, M.** (1976) Studies on the intestinal microflora of salmonids. I. The intestinal microflora of fish reared in fresh water and sea water. *Bull. Jpn. Soc. Sci. Fish.*, **42**, 91–99.

# La inspección y el control de calidad del pescado en el Perú*

**C. Alegre. S.**
Empresa Publica de Certificaciónes Pesqueras del Perú, Péru

## Summary

The Conference on Fish Inspection and Quality Control held in Halifax, Canada in 1969 has served as a guidance and direction for many countries with fishing interests, especially those that are establishing or developing fish inspection and quality control programmes.

Up to 1970, the fishing industry in Peru was dedicated almost exclusively to the production of fish meal. From that time on, with the creation of a Ministry of Fisheries and the development of an FAO Project for the Commercialisation and Utilisation of Fish, a new impetus was given to the programmes for the development of a fish industry for human consumption.

Among the most outstanding programmes that were performed with the advice of FAO it is important to mention the one related to the establishment of a Fish Inspection Service. This programme was initiated in Empresa Publica de Certificaciones Pesqueras del Peru (CERPER) in 1971 with a central laboratory dedicated to the inspection and certification of fishing products destined for export.

The present paper refers to the experience gained and the difficulties encountered with the operation of an organization not only concerned with the quality of finished products but also actively participating in the improvement of the efficiency of the industry in all its aspects.

## Résumé

La Conférence sur l'Inspection et le Contrôle de Qualité du Poisson tenue à Halifax, Canada, en 1969 a servi de guide et de directive aux nombreux pays s'intéressant aux problèmes de la pêche, spécialement à ceux qui sont en train de créer ou de développer des programmes d'inspection et de contrôle de qualité du poisson.

Jusqu'en 1970, l'industrie du poisson au Pérou a été consacrée presque exclusivement á la production de farine de poisson. Depuis ce moment, avec la création d'un Ministére de la Pêche et le développement d'un Programme FAO pour la Commercialisation et l'Utilisation du Poisson, un nouvel élan a été donné aux programmes de développement d'une industrie du poisson pour la consommation humaine.

Parmi les programmes les plus remarquables réalisés sur le conseil de la FAO, il est important de mentionner celui relatif à la création d'un Service d'Inspection du Poisson. Ce programme a été commencé par l'Empresa Publica de Certificationes Pesqueras del Peru (CERPER) en 1971, avec un laboratoire central consacré à l'attestation de garantie des produits de la pêche destinés à l'exportation.

Le présent article fait état de l'expérience acquise et des difficultés rencontrées dans le fonctionnement d'un organisme non seulement chargé de la qualité des produits finis mais participant également à l'amélioration de l'efficacité de l'industrie sous tous ses aspects.

## Resumen

La Conferencia sobre Inspección y Control de Calidad del Pescado, celebrada en Halifax, Canadá, en 1969, ha servido como guía y dirección para muchos países con intereses pesqueros, especialmente para aquellos que están estableciendo o desarrollando programas de inspección y control de calidad del pescado.

Hasta 1970, la industria pesquera del Peru estaba dedicada casi exclusivamente a la producción de harina de pescado. Desde dicha fecha, con la creación de un Ministerio de Pesca y el desarrollo de un Proyecto de la FAO para la Comercialización y Utilización del Pescado, se ha dado un nuevo ímpetu a progamas para el desarrollo de una industria pesquera para consumo humano.

Entre los programas más sobresalientes que se han llevado a cabo con el asesoramiento de la FAO, debe resaltarse uno relacionado con el establecimiento de un Servicio de Inspección del Pescado.

Este programa se inició en la Empresa Pública de Certificaciones Pesqueras del Peru (CERPER) en 1971, con un laboratorio central dedicado a la inspección y certificación de productos pesqueros destinados a la exportación.

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*An English translation of this paper is available from the Tropical Products Institute.

El presente informe trata de la experiencia adquirida y las dificultades encontradas en el funcionamiento de una organización no solamente relacionada con la calidad de los productos acabados, sino también participante activa en la mejora de la eficiencia de la industria en todos sus aspectos.

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## La pesca para consumo humano en el Perú

Las docientas millas de mar territorial peruano abarcan un área comprendida approximadamente entre los 3 y los 18° de latitud sur. Contrario a lo que uno pudiere esperar por su cercanía a la región ecuatorial, las características del mar peruano corresponden a las de un mar subtropical, mas bien templado, con temperaturas superficiales promedio de 15 a 18°C. Sólo en el extremo norte del país y cuando sucede el 'Fenómeno del Niño', se puede encontrar aguas tropicales cercanas a la costa.

Los recursos pesqueros que habitan en esta area son abundantes, siendo la anchoveta (*Engraulis ringens*) la especie màs significante y eslabón principal del sistema ecológico del mar peruano. De relativa abundancia son también las siguentes especies pelágicas o semipelágicas: la sardina (*Sardinops sagax*), el jurel (*Trachurus symmetricus*) y la caballa (*Scomber japonicus peruanus*). Todas ellas se encuentran a lo largo de la costa, aunque la caballa es más predominante en la región central norte del país. El litoral peruano tiene una muy estrecha plataforma continental y sólo en la región norte ésta avanza hasta unas 80 a 120 millas en un área relativamente estrecha. En esta región existe una pesquería de fondo con una serie de especies, siendo la merluza (*Merluccious gayi*) la más abundante.

La industria de procesamiento para consumo humano se inició en el Perú hace unos 30 años dedicándose principalmente a la elaboración de conservas de bonito (*Sarda chiliensis*). Esta industria tuvo su mejor época alrededor de los años 60, después de lo cual paulatinamente los desembarques de bonito fueron haciéndose menores, teniendo la industria que recurrir al uso de otras especies, tales como el jurel, la caballa y la sardina. Sólo después del año 1970 se realizan nuevas inversiones en la industria de procesamiento para uso humano, cuando el Estado plantea una política agresiva para el desarrollo de ese tipo de actividad. En el momento actual, la industria pesquera de consumo, cuenta con alrededor de 45 plantas industriales, en su mayoría pequeñas aunque en el ùltimo, año se han creado dos (2) complejos industriales, de gran magnitud y elevado nivel tecnológico. Asímismo en los últimos años el Estado viene trabajando con flotas extranjeras de barcos factoría, los cuales básicamente se dedican a elaborar productos congelados a base de merluza.

En el momento actual se elaboran en el Perú para el mercado nacional y de exportación, los siguientas productos:

*Conservas*

(a) En envases 'Tuna de 1/2 libra', las presentaciones sólido, 'chunk', 'flakes' y 'grated,' con las especies atún (*Thunnus albacares*), barrilete (*Katsuwonus pelamis*), bonito, caballa y jurel.

(b) En envases 'tall' de 1 libra (408 x 301) en salumera a la sardina, caballa y el jurel (pequeño).

(c) En envases ovales de 1 libra, básicamente la sardina en salsa de tomate y también al machete (*Brevoortia maculata*).

(d) Algunas conservas de mariscos tales como choros (*Aulacomya ater*), machas (*Mesodesma donacium*) y caracoles (*Concholepas concholepas*).

*Productos congelados*

(a) Pescado entero; atún, jurel, caballa y especies diversas.

(b) Pescado 'dressed'; principalmente la merluza en empaques de 5 libras.

(c) Filetes de merluza ya sea como bloques o congelados individualmente, con o sin piel, porciones de filetes.

(d) Camarones crudos y con cáscara en empaques de 5 libras.

(e) Carne de cetáceos, principalmente del cachalote y en mucho menor escala de ballenas.

*Otros productos*

(a) Salchichas de pescado, a base de carne de merluza.

(b) Merluza salada y seco salada.

El auge de la industria de congelamento en los últimos años (Tabla 1) se debe principalmente a la operación de ocho barcos factoriá que vienen operando bajo contrato especial con el Estado. Estos barcos producen principalmente bloques de filetes y merluza 'dressed'.

Asímismo, es importante recalar que en los últimos años el Estado ha realizado notables inversiones con el objeto de mejorar las condiciones o facilidades para la recepción y distribución del pescado, contándose actualmente con alrededor de 18 centros de acopio y distribución tanto en la costa (Terminales Pesqueros), como en el interior del país (Frigoríficos Pesqueros), que son administrados por la Empresa Pública de Servicios Pesqueros (EPSEP).

## Reseña historica

La primera organización que se dedicó en el Perú e la inspeción de la calidad del pescado fue el Laboratorio de Tecnología Pesquera del Ministerio de Agricultura. Este laboratorio fue organizado bajo el asesoramiento del tecnólogo norteamericano Norman Jarvis, en el año 1950. Sin embargo, la labor que desempeñó este laboratorio sólo estuvo relacionada con la inspección de calidad de los productos pesqueros importados, principalmente conservas.

TABLA 1. *Estadisticas de Pesca y Utilización entre los Años 1967 a 1974 (en TMB de materia prima)*
*Fishery statistics and utilization between the years 1967 and 1974 (tonnes of raw material)*

| *Ano (Year)* | *Conservas (Canned produce)* | *Congelado (Frozen)* | *Salado (Salted)* | *Fresco (Fresh)* | *Otros (Others)* | *Total* |
|---|---|---|---|---|---|---|
| 1966 | 42,679 | 15,856 | 26,374 | 72,360 | – | 157,269 |
| 1967 | 26,546 | 27,685 | 42,033 | 79,090 | – | 175,354 |
| 1968 | 24,892 | 21,073 | 24,261 | 78,347 | – | 148,573 |
| 1969 | 27,199 | 21,365 | 22,642 | 95,286 | – | 166,492 |
| 1970 | 34,409 | 24,244 | 18,981 | 107,747 | – | 185,381 |
| 1971 | 53,166 | 24,046 | 8,625 | 119,341 | 1,217 | 206,395 |
| 1972 | 65,755 | 12,155 | 7,586 | 127,493 | 782 | 212,897 |
| 1973 | 64,590 | 58,520 | 11,002 | 160,151 | 904 | 295,167 |
| 1974 | 82,751 | 78,961 | 15,387 | 140,059 | 1,028 | 318,186 |

Source: Ministerio de Pesquería, Division de Información y Estadística, Instituto del Mar. Informe N° 26, Enero 1969. (Ministry of Fisheries, Division of Information and Statistics, Institute of the Sea. Information No. 26, January 1969).

Esta reducida labor prácticamente se siguió realizando hasta el año 1971 cuando el Estado, por intermedio de su Ministerio de Pesquería creo una organización a la que se le otorgó la responsabilidad para la inspección y el control de la calidad del pescado y los productos pesqueros, tanto aquellos destinados al consumo humano como los productos para consumo animal o uso industrial.

Esta nueva organización llamada Empresa Pública de Certificaciones Pesqueras del Perú (CERPER) se formó sobre la base del Laboratorio de Tecnología Pesquera y sobre un laboratorio particular que se dedicaba a la inspección y certificación de la calidad de la harina de pescado sujeta a exportación. Al poco tiempo de formado CERPER, un comité de rapresentantes de diversas entidades gubernamentales tales como Ministerio de Salud Pública, Gobiernos Municipales, Ministerio de Pesquería, Instituto de Normas técnicas, Sociedad de Pesquería y CERPER, se encargó de plantear los objetivos y funciones de CERPER en el campo de la inspección y el control de calidad del pescado y los productos pesqueros para uso humano. De esta manera se formó en CERPER un cuerpo dedicado exclusivamente a los productos para uso humano. Legalmente esta organización denominada Servicio de Inspección de Pescado, asumía básicamente la función de Autoridad Sanitaria en el campo pesquero, teniendo como respaldo la ley de creación de CERPER y la Ley 17505, Código Sanitario, o Ley Sanitaria del país.

## Organizacion

CERPER cuenta con cuatro organizaciones básicas, las que cumplen las funciones que le otorga la ley, y son:

1. El Servicio de Inspección de Pescado, tal como se ha indicado, es el organismo del Estado responsable de la inspección y el control de calidad del pescado y los productos pesqueros para uso humano.
2. Un laboratorio para la inspeccion de harina y aceite de pescado que se encarga de la inspección certificación de estos productos básicamente para la exportación.
3. El departamento para la inspección de productos agropecuarios que actúa sólo para los casos de importación de productos agropecuarios. Su labor principal es verificar el cumplimiento de los requisitos de calidad de los lotes importados, no sólo desde punto de vista sanitario sino, de la calidad especificada en los contratos, actuando a solicitud de las agencias estatales de importación.
4. Un departamento de servicios de almacenaje financiero para el otorgamiento de 'warrants' o certificados de mercadería en prenda. Originalmente trabajaba con lotes de harina de pescado pero, en el momento actual da servicios practicamente con cualquier tipo de productos.

El Servicio de Inspección de Pescado inició sus tareas desarrollando un programa de inspección rutinaria de pescado fresco y productos procesados. El objetivo del programa fue básicamente proteger la salud del consumidor impidiendo el comercio de productos descompuestos, sucios, contaminados o que de algún modo representen peligro para la salud del consumidor.

Para cumplir con este objetivo, el Servicio cuenta con una organización descentralizada para la inspeccion del pescado fresco en los puertos y mercados mayoristas y una organización centralizada para la inspección de la calidad de los productos procesados.

### *Servicio de inspección de pescado fresco*

La inspección del pescado fresco se empezó en el puerto del Callao y en el Mercado Mayorista Pesquero de Lima, y posteriormente se amplió a dos de los puertos más importantes con respecto al desembarco de pescado: Paita y Parachique. Se consideró iniciar el programa de inspección sólo en aquellos lugares donde existiese un sistema adecuadamente organizado de comercio. Una agencia estatal, la Empresa Pública de Servicios Pesqueros (EPSEP), desempeña las tareas de administración de los principales puertos pesqueros y centros de comercio y distribución y en muchos casos actúa como comprador mayorista.

Al iniciarse este programa de inspección, se consideró que éste cumpliría con los siguientes objetivos:

(a) Impedir que pescado descompuesto, contaminado, o inapto para uso humano ingrese al sistema de comercialización para el consumo fresco o sea utilizado por la industria, como materia prima para un posterior procesamiento para uso humano.

(b) Facilitar las prácticas de comercio actuando como juez o tercera posición entre el que vende, pescador o armador y el que compra, mayoristas o el propio EPSEP, en asuntos de calidad.

(c) Tomar información detallada de los problemas que suceden en los puertos o mercados relacionados con los métodos de manipuleo y conservación.

Este programa se viene cumpliendo, para lo cual se cuento con cinco estaciones de inspección con un total de 50 inspectores que prestan servicios 24 horas al día de seis a seite días en la semana según las estaciones.

La cantidad de pescado rechazado en los puertos es notoriamente alta, especialmente aquél que proviene de embarcaciones que utilizan redes de cerco (bolicheras). En algunos meses del año, se ha comprobado que más de un 50% de la captura termina siendo reducída a harina de pescado.

El origen de esta situación está relacionada con las embarcaciones pesqueras, la mayor parte de las cuales fueron originalmente embarcaciones para suministrar anchoveta a las fábricas de reducción. No se ha tenido una legislación apropiada que impida que una embarcación sin condiciones mínimas de diseño de bodegas y métodos de conservación, se dedique a la pesca para uso humano.

Asímismo, el sistema de licencias de operación para embarcaciones no está todavía bajo control de Servicio. Sin embargo, para el presente año se espera que con una nueva legislación sanitaria en el campo pesquero, el Servicio podrá iniciar adecuadamente un programa de inspección de embarcaciones.

### *La inspección de productos procesados*

A partir de la formación de CERPER, todos los productos procesados fueron sujetos a un programa de inspección de calidad. El objetivo del programa fue el de protección del consumidor asegurándole un mínimo de calidad, básicamente la sanitaria.

Aún cuando la industria conservera está localizada prácticamente en todo el litoral, cada código de producción es muestreado y las muestras despachadas al laboratorio central del Servicio.

La tarea de muestre se realiza coordinadamente con otros departamentos de CERPER que tienen estaciones y oficinas en muchos lugares diferentes de la costa.

La inspección de productos congelados inicialmente se hizo sólo de los productos que ingresaron a la capital. Posteriormente, al organizarse una estación para la inspección del pescado fresco en el puerto de Paita se asignó a esta estación también la vigilancia de la calidad de los productos congelados producidos por la industria localizada en ese lugar (seis plantas).

Los problemas de calidad encontrados en los productos congelados se deben principalmente a: pobre calidad o estado de frescura de la materia prima utilizada; temperaturas inadecuadas de almanenamiento; y deficientes sistemas de venta al minorista consumidor.

## Financiamiento

CERPER como un todo, inclusive el Servicio de Inspección de Pescado es financiado mediante el cobro directo de servicios o más propiamente, mediante el cobro de un impuesto directo referido al monto de la producción, existiendo tarifas para cada tipo de productos, salvo el pescado fresco. Asímismo, CERPER se financia con ingresos de otro tipo de actividades, como el del almacenaje financiero ('warrants') cobrando un porcentaje sobre el monto del valor de la mercadería prendada.

## Personal

El reclutamiento de personal calificado ha sido uno de los problemas más serios con que ha hecho frente el Servicio de Inspección.

Aún cuando desde un inicio se decidió utilizar a graduados universitarios en ciencias o tecnología pesquera de alimentos o campos afines, en el Servicio de Inspección, ha tomado unos cuatro años antes de que se pueda contar con personal eficiente y conocedor de su oficio. Sin embargo, se tiene la precaución de por lo menos anualmente, realizar cursillos de refresco o entrenamiento para el personal de inspectores de campo.

## Legislacion

Para el desarrollo de un programa de inspección y control de calidad a nivel estatal, sen necesarias las siguientes consideraciones: autoridad legalmente instituída para realizar inspecciones; y autoridad para el control de calidad del pescado y productos pesqueros.

Durante sus primeros cinco años de trabajo, el Servicio ha trabajado casi exclusivamente en el camp de la inspección, por existir dispositivos legales confusos sobre quien debe realizar las tareas de promoción y desarrollo de la calidad del pescado y productos pesqueros. En el presente se está haciendo una revisión del Código Sanitario mediante la cual se definirá el rol del Servicio de Inspección de Pescado como entidad promotora de la calidad, debiéndose realizar una serie de programas en este campo durante el bíenio 1976–1977. Los objetivos que se persiguen con esta revisión son:

(a) Definir fundamentalmente la responsabilidad de CERPER y específicamente del Servicio de Inspección de pescado como única autoridad de inspección aún a nivel minorista y de consumidor.

(b) Coordinar y hacer armónicos los términos y conceptos usados en este Código con relación a los utilizados en las Normas Técnicas Nacionales, Codex u otra legislación existente, cuando se considere necesario.

(c) Definir la responsabilidad de CERPER como Institución de Control de Calidad.

(d) Centralizar en CERPER una serie de funciones importantes de control, especialmente el otorgamiento de licencias (para embarcaciones pesqueras, plantas de procesamiento, vehículos de transporte, etc).

### Programa para corto plazo

El Servicio de Inspección tiene planeado cumplir con la metas en el bienio 1976–1977:

(a) Reducir al máximo el dispendio y mal uso del pescado evitando que éste se destine a la fabricación de harina de pescado. Se realizan la siguientes acciones:
    Desarrollo de legislación apropiada.
    Programa de difusión sobre conservación de recursos y métodos de preservación del pescado entre los pescadores.
    Programa de inspección de embarcaciones y otorgamiento de licencias.

(b) Mejorar fundamentalmente el nivel higiénico y sanitario de las plantas de procesamiento, mediante:
    Programa de capacitación entre los operarios de plantas.
    Desarrollo de legislación apropiada.
    Programa de inspección de plantas de procesamiento y otorgamiento de licencias.

(c) Mejoramiento de las condiciones de venta al consumidor de pescado y productos pesqueros, mediante:
    Coordinación con los gobiernos municipales con el propósito de entrenar a inspectores municipales.
    Coordinando con otras agencias estatales, ei, Centro de Educación del consumidor, con el objeto de difundir criterios sobre calidad de pescado al consumidor.
    Difundiendo literatura técnica sobre métodos de conservación y productos pesqueros.

### Cooperacion tecnica

Después de haber sido asistido entre el año 1971 y 1974 por un Proyecto FAO/UNDP, principalmente mediante la provisión de expertos, en el momento actual, CERPER viene recibiendo ayuda técnica a través de un Proyecto con CIDA (Canadian International Development Agency). Mediante este Proyecto el Servicio de Inspección recibe asistencia permanente de expertos, equipo de laboratoria, material bibliográfico, entrenamiento de inspectores y lo que es fundamental, el soporte director de una de las agencias más prestigiadas del mundo en inspección y control de calidad de pescado como es la institución canadiense.

### Conclusiones

Paralelamente a los programas para el desarrollo de una industria moderna para el procesamiento de pescado, el Perú se ha propuesto contar con una eficiente y prestigiada organización para la inspección y el control de calidad del pescado y los productos pesqueros, que no sólamente participe garantizando al consumidor nacional, productos saludables y de buena calidad, sino también que propicie el ingreso de los productos peruanos a nuevos y mejores mercados de exportacion.

El inicio ya se ha dado y es el propósito de tener en corto plazo, una institución de nivel comparable con el de las mejores similares de otros países del mundo.

# Fish inspection and quality control in Brazil

**C. A. M. Lima dos Santos**
Ministry of Agriculture, Brazil

## Summary

This paper reviews the fish inspection and quality control procedures in Brazil. Responsibility for industrial and sanitary fish inspection in Brazil rests exclusively with the Ministry of Agriculture.

For ease of analysis the report gives a previous background of the geography, climate, economic conditions and the fishing industry of Brazil.

All fish handling and processing establishments are subject by a federal law to a mandatory industrial and sanitary inspection. Fishery inspectors, strategically located in major fish landing areas and processing communities in Brazil, check the quality of fish daily as it is unloaded from fishing vessels, in the holding rooms and along the processing lines in the plants throughout an in-plant continuous inspection system. Fish and fishery products which do not comply with minimum legal standards for freshness and wholesomeness are disposed of as fish meal. Great attention is also given to technical assistance to all levels of the fishing industry.

The paper also reports on legislation, including plant and product standards, organization of the Inspection Service, methods of applying inspection and quality control at the dockside, in processing plants and at the wholesale and retail levels, testing methods employed and the recruiting and training of inspection staff.

## Résumé

Cet article passe en revue l'inspection du poisson et les méthodes de contrôle de qualité au Brésil. La responsabilité de l'inspection industrielle et sanitaire du poisson au Brésil dépend exclusivement du Ministère de l'Agriculture.

Pour la facilité d'analyse, le rapport donne un aperçu préalable de la géographie, du climat, des conditions économiques et de l'industrie du poisson au Brésil.

Toutes les entreprises manipulant ou traitant le poisson sont soumises par une loi fédérale à une inspection industrielle et sanitaire obligatoire. Des inspecteurs de la pêche installés aux points stratégiques les plus importants de débarquement et de traitement du poisson vérifient chaque jour au Brésil la qualité du poisson au moment où il est débarqué des bateaux de pêche, dans les locaux de vente et tout au long des stades de préparation dans les usines à l'aide d'un système d'inspection continue en usine. Le poisson et les produits de la pêche qui ne satisfont pas aux réglements légaux minimum en ce qui concerne la fraicheur et la salubrité sont réservés à la fabrication de farine de poisson. Une grande attention est également portée à l'assistance technique à tous les stades de l'industrie du poisson.

L'article fait également état de la législation, y compris les règles pour les usines et les produits, l'organisation du service d'inspection, les méthodes d'application de l'inspection et le contrôle de qualité à quai, dans les usines de traitement et aux stades de commerce en gros et en détail, testant les méthodes employées ainsi que le recrutement et la formation du personnel d'inspection.

## Resumen

Este artículo hace una revisión de los procedimientos de control de calidad e inspección pesquera en el Brasil. La responsabilidad de la inspección pesquera sanitaria e industrial en el Brasil depende exclusivamente del Ministerio de Agricultura.

Para facilitar el análisis, el informe pone en antecedentes sobre la geografía, el clima, las condiciones económicas y la industria pesquera del Brasil.

Todos los establecimientos de manipulación y elaboración del pescado están sujetos por una ley federal, a la inspección sanitaria e industrial obligatoria. Los inspectores de pesca que están estratégicamente situados en las principales zonas pesqueras terrestres y en las comunidades de elaboración del Brasil, controlan la calidad del pescado a diario cuando se descarga de los barcos pesqueros, en las zonas de recepción, y a lo largo de las líneas de procesado durante todo el sistema de inspección continuo en la planta.

Los pescados y productos pesqueros que no cumplen con las normas legales mínimas en cuanto a frescura y a

salubridad se destinan a harina de pescado. Se dedica gran atención a la asistencia ténica en todos los niveles de la industria pesquera.

El artículo tambien informa sobre la legislación, incluyendo las normas sobre los productos e instalaciones, la organización del servicio de inspección, los métodos a aplicar en la inspección y el control de calidad en el muelle, en las plantas de procesado y en los niveles de venta al por mayor y al detalle, los métodos de prueba empleados y el reclutamiento y formación del personal dedicado a la inspección.

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### Introduction

Brazil is a continental country with an area of more than 8.5 million km$^2$ and an Atlantic coastline of about 8,300 km in length. As a large country Brazil has many different ecological features from one region to another. Being also a developing tropical country, Brazil is characterized by a difficult climate which affects the preservation of both fish and shellfish. Fishing methods, unloading, handling and processing techniques, trading and distribution chains change very much from one area to another and even within an area, running from the most up-to-date methods to the most rudimentary (Lima dos Santos, 1971).

Fisheries in Brazil can be divided into the following geographical areas:

(a) Amazon – covering the Amazon Basin, a region with plenty of large rivers and lakes, surrounded by jungles, hot and humid all the year, with a very low population density.

(b) Northeast – covering the coastal states. A very dry and poorly developed region, but very rich in fisheries resources of high commercial value such as lobster and red snapper.

(c) Southeast – covering the coastal states which are the most developed and have the highest population. The important sardine and shrimp fisheries are found in this area.

(d) South – the southern coastal states are also well developed and populated. This is the most important region for groundfish.

(e) Central – this area includes the inland states with poorly developed fisheries, partially covered by the jungle and partially by the 'cerrado' (Lima dos Santos, 1971).

### The fishing industry

From Brazil's long coastline and its many huge rivers and lakes hundreds of different species of fish are commercially exploited. A total volume of 681,000 tonnes was landed in 1974 including fish, crustaceans, molluscs and whales.

In 1974 the catch consisted of the following:

| | |
|---|---|
| Croakers, bass, snappers and hake | 180,000 tonnes |
| Freshwater fish | 131,000 ,, |
| Sardines | 120,000 ,, |
| Crustaceans | 87,000 ,, |
| Molluscs | 7,000 ,, |
| Whales | 3,000 ,, |
| Jacks and mullets | 61,000 ,, |
| Others | 92,000 ,, |

According to official estimates there are 54,695 fishing vessels in Brazil. Of these 4,954 are engine powered, 20,614 are sailing and 29,127 rowboats. Of the engined fishing fleet there are 823 vessels with a capacity of over 20 tonnes, as follows:

| | |
|---|---|
| Trawlers | 477 |
| Trainers | 129 |
| Lobster boats | 129 |
| Liners | 51 |
| Combined vessels | 35 |
| Whalers | 1 |
| Factory-ships | 1 |

Artisanal fishing is still important to the economy of Brazil. Of the 300,000 professional fishermen throughout the country, at least two-thirds are artisanal, contributing approximately 46% of the total Brazilian catch. This contribution rises to 50% in the northeast and 100% in the major river systems of the country.

### *Fish handling and preservation on board*

In Brazil, a few lobster boats and shrimp trawlers have freezing facilities but the majority of the fishing fleet employs ice to preserve its catch. Ice is not used by the small artisanal craft.

Some species such as sharks, flounders, squirrel hake and conger eel are gutted at sea. Shrimp are, in general, beheaded on board the large shrimp trawlers which operate in the area of Belem. Rock lobsters are brought ashore alive from nearby grounds whilst others are killed and beheaded at sea. All other species are landed ungutted.

In general fish are not sorted for size or species on board; whole fish are stowed with loose ice in the bins of the wooden holds.

TABLE 1. *Volume of inspected Brazilian production (tonnes) from 1970 to 1974*

| *Products* | *1970* | *1971* | *1972* | *1973* | *1974* |
|---|---|---|---|---|---|
| Fresh | 99,030 | 91,963 | 85,033 | 81,152 | 131,600 |
| Frozen | 42,410 | 66,444 | 73,594 | 58,109 | 69,402 |
| Cured | 32,439 | 42,858 | 42,955 | 45,979 | 59,280 |
| Canned | 39,560 | 33,476 | 42,887 | 58,925 | 51,049 |
| Others | 3 | 56 | 367 | 144 | 100 |
| By-products | 12,559 | 20,387 | 18,891 | 32,563 | 29,125 |
| *Total* | 226,001 | 255,184 | 263,772 | 276,872 | 340,556 |

### *The fish processing industry*

Brazil today has 263 fish processing establishments that are responsible for a production of 341,000 tonnes of fish and fishery products. The quantities of the different products inspected by the Federal Authorities between 1970 and 1974 are shown in Table 1.

Table 1 refers only to fish and fishery products processed in establishments under federal inspection. Further quantities of cured fish are produced in small establishments not yet submitted to federal inspection.

### *Fresh fish handling ashore*

The largest percentage of fish consumed in Brazil is in a fresh (iced) condition. Fresh fish is almost always sold at the retail level by small fishmongers, city food markets and increasingly through supermarket chains.

Unloading of fresh fish is generally carried out in several different places without the benefit of an organized centralized system. There are only a few government landing places where the fishing vessels can unload their catches and sell it direct to the buyers. Commonly, the unloading operation takes place on lake or river shores, sandy beaches or small wooden docks, without any protection against sunlight, wind or rain (Lima dos Santos, 1973).

At some fish processing establishments under federal inspection the fishing vessels unload at nearby wharves but, in many cases, they unload some distance away and the fish are transported by truck to the plant. Fish are unloaded from the boats in fibre baskets which are then lifted or hoisted by use of a rope and pulley to the pier. There are a small number of plants employing an air-pumping system ('air-flow' system) for unloading (McNeill, 1970). After unloading the fish are placed in a metallic rotary washer discharging onto a conveyor belt where workers grade the fish according to size, quality and species and place them into plastic boxes. These boxes are iced and may go into insulated trucks to be transported to the several fresh fish markets or be held for further processing (freezing, canning, curing, etc).

### *Frozen fish production*

The introduction of refrigeration, about 15 years ago, has been a major technical factor in many recent developments. About 70% of Brazilian fish processing plants have cold storage and freezing facilities. Mainly sardines, croakers, mullets, anchovy, pampanos and snappers are frozen in the round or headed and gutted. Frozen fillets and steaks, produced from freshwater catfish, weak fish, snappers, croakers and hake, are also important in the northern and southern areas. Headless and peeled shrimp are produced by many plants all along the coastline. Rock lobster tails are frozen in the northeast area and almost the whole production goes for export. Frozen scallops and blue crab meat are produced in the south.

Blast freezers, plate freezers, brine freezers and flow freezers are all in use and the cold rooms maintain temperatures considered satisfactory by most authorities (Boothby, 1968; McNeill, 1970).

Many processing plants are mechanized particularly those dealing with shrimp. Peelers, deveiners and graders are employed by a great number of companies.

### *Cured fish production*

In the southern areas, sardines, mullets, croakers, catfish, hake, sharks and shrimp are all made into salted products. Flying fish and whale meat are also salted in the northeast areas. Several freshwater species are salted in the inland regions, pirarucu being the most important of them.

Only a few species are dried after salting, pirarucu and shrimp are the most common. Pickle curing is almost the only method employed all over the country. In order to get a lower percentage of moisture, fish are pressed after curing. An average period of 10 to 20 days is used in curing fish and the final moisture content is about 40 to 60% with a salt content between 15 and 18%. Almost half of the salt processing plants have cold storage facilities to keep the final products; however, in the consumption areas these facilities are generally absent.

Very little of this cured fish is of good quality when it reaches the consumer in the poorer inland areas of the country. All too often one sees dark brown rancid products, affected with red bacteria or partially fermented or spoiled. This is mainly due to a lack of a good refrigeration chain for distribution (Lima dos Santos, 1973).

### *Canned fish production*

Fish canning in Brazil was the first modern processing method to be established in the country and it is still the most developed. Sardine is the main species to be canned and the canneries are located in the southeast region. Mackerel, tuna and bonito are also canned in some of these plants. In the southern area there are a few plants which can mullet, catfish, anchovy, shrimp, blue crab meat and some lean fish such as hake, croakers and bass.

The plants are highly mechanized and heading, gutting and filleting machines are employed by all sardine and mackerel canneries. Continuous pre-cookers, automatic fillers and sealers imported from European countries have also been introduced in the Brazilian sardine canneries.

### *Fish meal and oil production*

Fish meal and oil are only produced in the southeast and southern regions using waste material from the sardine canneries and filleting plants as well as fish considered unfit for human consumption. However, two or three plants are using whole sardine and mackerel as raw material for reduction purposes.

### *Fish transportation*

The transportation of fish is almost entirely by road. In general the trucks used for this transport employ the 'iso-thermal' system, this being the refrigeration system only utilized for the frozen products. Air-freight is used for the more expensive types of fish, whose final sale price allows the high freight rates charged. Sea and railroad transportation is minimal.

### *Fish consumption and marketing*

Brazil has a population of 120 million inhabitants with a per capita income calculated at 500 US dollars. However, fish consumption is low and the consumption of fish per person is less than six kilos per year. The main reasons for this low consumption are: lack of habit of preparing and consuming fish by the local population; relatively low prices of beef, enabling most of the urban population to purchase it; long distances between producing and consuming centres, adding a high freight cost to fish; and an inadequate distribution network and facilities.

Nevertheless, it is worth mentioning that Brazil consumes about 80% of its fish production, valued at about 200 million US dollars, plus the 59 million US dollars of fishery products purchased from other countries each year. The import and export of fishery products for 1970 to 1974 are shown in Table 2. Brazilian fish exports, in spite of increases in recent years, are still less than imports. In 1974 the imports were around 59 million dollars, exports were around 48 million.

Rock lobster was the main export (56.2%) followed by shrimp (16.6%) and the frozen products, mainly freshwater catfish steaks and fillets, 15% (Table 3). Scallops constitute another frozen fish product with great prospects of becoming an important export. In 1974 Brazil rose to the third position as scallop supplier to the North American market, exporting 448 tonnes. In the fish preserve section, canned sardines and mackerel are the most important items exported. Recently, they have found new markets and the volume of exports has increased considerably. Our main buyer for these exports is the USA (more than 70%) followed by the Argentine, Japan and France. Today, new markets are being opened in Africa, and South and Central America.

TABLE 2. *Brazilian fish exports and imports by volume and value from 1970 to 1974*

| | *Exports* | | *Imports* | |
|---|---|---|---|---|
| *Years* | *Volume (tonnes)* | *Value (US $)* | *Volume (tonnes)* | *Value (US $)* |
| 1970 | 10,408 | 19,384 | 62,564 | 34,989 |
| 1971 | 12,145 | 27,179 | 52,330 | 34,114 |
| 1972 | 18,836 | 39,491 | 39,913 | 33,231 |
| 1973 | 18,747 | 35,602 | 54,286 | 54,286 |
| 1974 | 16,879 | 48,042 | 49,592 | 59,070 |

TABLE 3. *Brazilian exports of frozen and canned fish products in 1974 (tonnes)*

| | *Frozen products* | | | | *Canned fish* |
|---|---|---|---|---|---|
| *Countries* | *Fish* | *Rock lobster* | *Shrimp* | *Scallops* | |
| USA | 6,877 | 3,068 | 1,045 | 329 | 606 |
| The Argentine | 663 | – | 305 | – | 20 |
| Japan | 1 | – | 609 | 20 | – |
| France | 30 | – | 11 | 82 | – |
| European countries | 62 | 1 | 55 | – | 20 |
| African countries | – | – | 21 | – | – |
| South and Central American countries | 90 | – | – | – | 30 |
| *Total* | 7,723 | 3,069 | 2,046 | 431 | 676 |

Brazil imports mainly salted and dried codfish which represents 81% of all its foreign fish purchases in value. The main supplier is Norway. Besides the codfish, Brazil also imports fresh and frozen fish mainly from Uruguay and the Argentine. The third item of Brazilian imports is canned tuna and bonito, Peru and Ecuador being the main suppliers.

## Fish inspection and quality control

### *Legislative authority*

Industrial and sanitary inspection of all food of animal origin is a statutory obligation of the Ministry of Agriculture through its National Department of Inspection of Products of Animal Origin (DIPOA). DIPOA started to operate in the early 1920's but only began to inspect fish and fishery products in 1950. Until then fish inspection was a function of the old Division of Fish and Wildlife. Until 1971 DIPOA was only responsible for the inspection of products for interstate and international trade. Products for internal consumption (within each state) were inspected by state and municipal authorities. In 1971 'the federalization law' was passed; this made the Federal Government, through DIPOA, responsible for all fish inspection.

Legislation governing the inspection of processing plants, their products, labellings, marks, international trade etc was contained in a federal law approved in 1952: 'regulations for the industrial and sanitary inspection of products of animal origin'. Legal amendments were also passed in 1962, 1971 and 1975.

### *Organization*

Within DIPOA the planning direction, co-ordination, supervision and execution of fish inspection and quality control are under the Division of Inspection of Fish and Fishery Products (DIPES). The Divisional Headquarters at Brasilia, DF and its Regional Operating Branches must provide an integrated and uniform fish inspection programme throughout Brazil, functioning in all states and territories.

For the purpose of fish inspection, Brazil is divided into 24 Fish Inspection Districts with a Fish Inspection Station (POINS) in each one of them (Figure 1). Each

**Figure 1**
**Fish inspection districts and regional division**

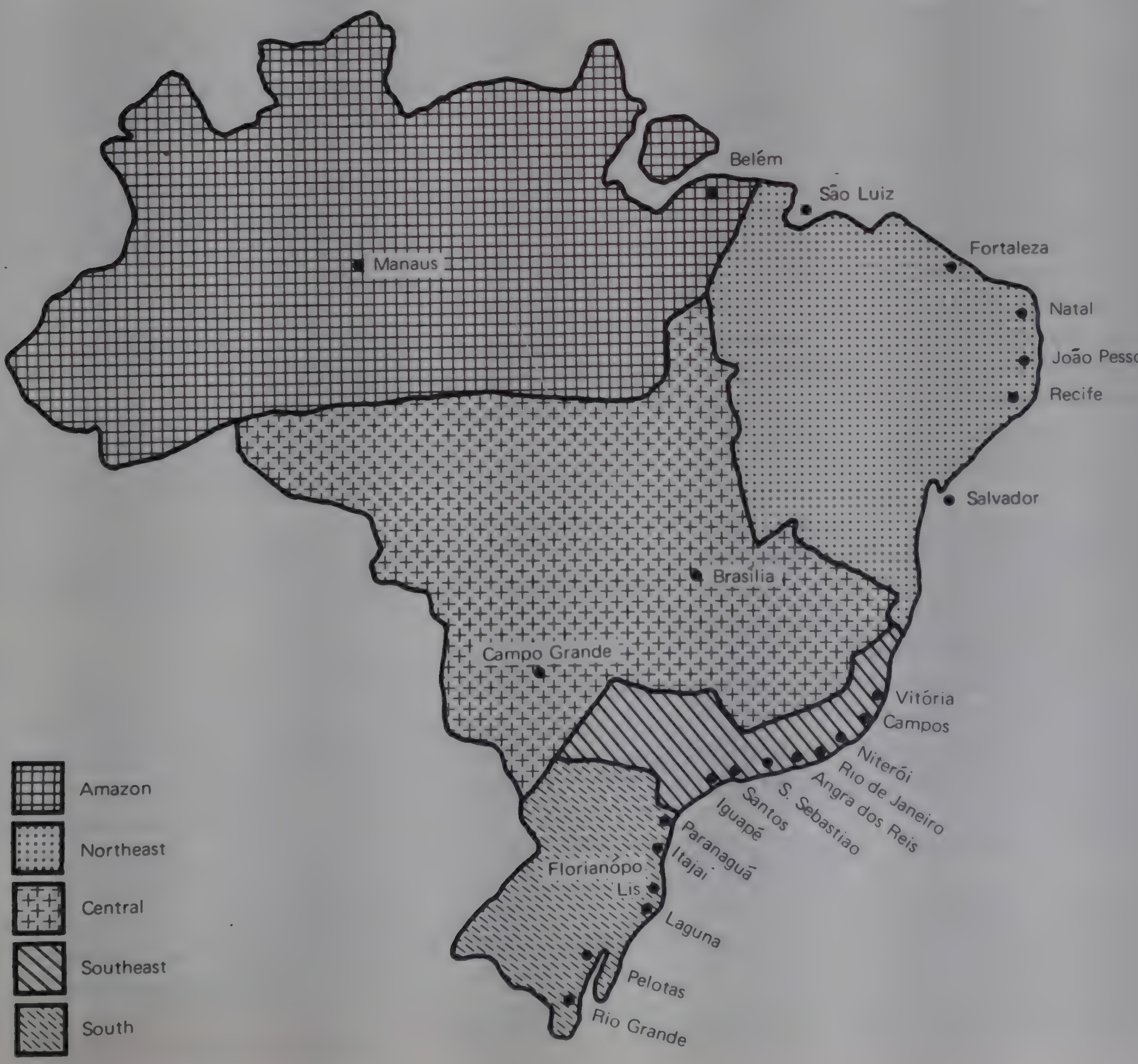
Belém
São Luiz
Fortaleza
Natal
João Pessoa
Recife
Manaus
Salvador
Brasilia
Campo Grande
Vitória
Campos
Niterói
Rio de Janeiro
Angra dos Reis
S. Sebastiao
Santos
Iguapé
Paranaguá
Itajaí
Florianópo
Lis
Laguna
Pelotas
Rio Grande
Amazon
Northeast
Central
Southeast
South

TABLE 4. *Number of inspected processing plants* and volume of production in 1974 (tonnes)*

| Region | *Fresh and frozen* |  | *Canned* |  | *Cured* |  | *Fish meal* |  |
|---|---|---|---|---|---|---|---|---|
|  | *Number of plants* | *Production* | *Number of plants* | *Production* | *Number of plants* | *Production* | *Number of plants* | *Production* |
| Amazon | 11 | 8,707 | – | – | 5 | 2,412 | – | 90 |
| Northeast | 26 | 5,864 | – | – | 1(†) | 1,111 | – | 1,087 |
| Southeast | 60 | 83,789 | 20 | 46,977 | 35 | 14,244 | 4 | 12,082 |
| South | 65 | 102,360 | 11 | 4,072 | 18 | 41,513 | 4 | 15,866 |
| Central | 3 | 290 | – | – | – | – | – | – |
| Total | 165 | 201,010 | 31 | 51,049 | 59 | 59,280 | 8 | 29,125 |

* Several processing plants have a mixed production (eg fresh and frozen plus cured or canned plus cured plus fish meal). In this table, the plant is listed according to its main activity.

†Shore whale station

station has one or more technically trained fish inspectors (they must be veterinarians according to Brazilian legislation). At the most important fish processing centres, DIPOA has a laboratory to perform routine analyses.

Practically trained fish inspectors inspect the main unloading places, fish processing plants and cold stores; they also maintain a continuous in-plant inspection system controlling the freshness, sanitation and quality of raw materials and end-products, the hygiene and operation of the fish processing lines, production in general and the labelling or marking of the products.

An ideal ratio of one technically trained fish inspector for each ten fish establishments and one practically trained fish inspector for each fish establishment is the aim of the Federal Inspection Service for its field activities.

The financial responsibility for the operation of the Inspection Service is shared between the Federal Government and the private industry, which contributes 40% of the expenses. The calculation for the private industry participation is based upon the volume of fish handled. The charge is around Cr $7.00 (seven cruzeiros)* for each tonne of fish, molluscs and whales and Cr$ 16.00 (sixteen cruzeiros) for each tonne of crustaceans (shrimps, rock lobster and crabs). On the other hand, the overtime for practical fish inspectors is entirely paid by industry. The number of plants involved may be seen from Table 4.

### *Objectives*

The main objectives of the Brazilian Fish Inspection Service can be outlined as follows:

(a) Protect the health of the consumer, ensuring the safety of the inspected products.
(b) Prevent fraud and deception, ensuring that fair trade practices are observed.
(c) Create confidence in consumers by trying to maintain a consistent level of good quality in fish and fishery products.
(d) Improve the quality of fish and fishery products.
(e) Improve the environment of handling, processing, storage and distribution.
(f) Increase the fish consumption.
(g) Develop the fishing industry as a whole.
(h) Improve the earnings of fishermen and industry.

### *Activities*

The activities of the headquarters element of the Inspection Service may be summarized as follows:

(a) Develops and prepares regulations for fish and fishery products in consultation with regional inspection staff, industry and other related Government agencies, as to: wholesomeness; quality, standards and product specifications; packing and labelling requirements; construction, equipment and operating requirements for the registration of fish establishments.
(b) Plans, directs, co-ordinates and evaluates the uniform application between regions of a national fish inspection programme.
(c) Plans, co-ordinates and evaluates, in consultation with regions, the activities of inspection laboratories and technical assistance programs to industry to upgrade fish quality and the fish processing environment.
(d) Analyses, approves and registers fish establishments, projects for new processing plants, improvements or enlargements, new equipment for fish processing, packaging, labels and marks for fish and fishery products.
(e) Maintains liaison with national organizations or agencies of foreign countries.
(f) Represents Brazil at international meetings and conferences concerning the development of international trading standards for fish and fishery activities.

The Regional Operating Branches plan, organize and operate integrated laboratory and field programmes, performing the following main activities:

(a) Primary quality inspection.
(b) Product identity and labelling compliance.
(c) Survey and control of construction and equipment of the fish establishments (floors, walls, ceilings, lighting, ventilation, equipment design, employee hygiene facilities, water supply, waste disposal).
(d) Survey and control of operating requirements (product handling, processing methods, in-plant sanitation, employee hygiene, insect control, product temperatures, sanitation of vehicles, boxes etc, maintenance of frozen product temperatures).

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*1 Brazilian Cruzeiro (Cr $) = £0.06 as at June 1976

(e) Product sampling and preparation for laboratory analysis.

(f) Release or supervise disposal of suspect produce.

(g) Improve plant layouts.

(h) Improve in-plant sanitation.

(i) Improve quality control.

(j) Implementation of new processing techniques.

(l) Education of fishermen, plant owners and plant employees on fish handling, employee hygiene, boat and plant sanitation.

### *Fish product and plant standards*

Brazilian regulations contain organoleptic standards of quality for fish, crustaceans and molluscs, chemical standards, and standards for wholesomeness for fresh, canned and cured fish. The regulations require that fish not meeting the standards outlined must be condemned and transformed into non-edible products. Specific regulation items are included for canned and cured fish products, fish meal and oil and for the labelling of such products.

The regulations lay down strict conditions for the construction, registration and operation of fish handling and processing plants covering location, water supplies, plant layouts, floors, walls, ceilings, lighting, ventilation, equipment design, employee hygiene facilities, waste disposal, minimum freezing and cold store temperatures, curing time, vehicles for fish transportation etc.

Apart from the regulatory matters, technical circulars are issued by the Directors of the Fish Inspection Service. A draft Standard for canned sardine, to be used by plant quality control personnel and inspection officers, was introduced to assess and grade the commercial quality of each lot of canned sardines for foreign markets. Advisory information was also issued when mandatory regulations were issued on the road transportation of fresh fish.

Codex Standards and Codes of Practice, already published or in the preliminary stages, are also translated and distributed among the industry and fish inspectors in order to make them familiar with technological advances and to study their practical applicability in Brazil. The technological and hygiene recommendations included in the Codex Codes of Practices for fresh, frozen and canned fish are being applied to fish handling and processing plants by the routine work of technical assistants of the Fish Inspection Service.

### *Methods of applying inspection and quality control*

The main philosophy behind the actions of the Brazilian Fish Inspection Service is active participation at all levels and places where there is a need for technical assistance, or control, or when there is a request for assistance.

Sites intended for the construction of a fish handling or processing establishment must be surveyed and approved by the local Fish Inspector. Samples of the water to be employed must also be analysed by the Regional Laboratories. A complete project must be presented to the Inspection Service for approval, without which construction cannot proceed. The same procedure is employed in the case of substantial changes or enlargements of already registered establishments.

For each product, handling or processing methods and equipment to be used, packing materials and labels must be analysed and receive the approval of the Inspection Service. Labels are also registered.

To exploit the international market, the establishments need a special authorization based upon technical and hygiene conditions, the nature of the product(s) intended to be exported and the country of destination.

Throughout the in-plant inspection, great attention is paid to the freshness and quality of raw materials, the docks and receiving areas requiring most attention.

At each unloading place it is mandatory to have facilities to wash, inspect and select the catches mechanically. Therefore, in every handling and processing plant there are one or more lines of a rotary washer drum connected with an inspection belt. The industry is responsible for quality control work, supervised by the in-plant fish inspection officer. Well trained, experienced workers select the catch by quality, species and size. Fish are selected into three grades with respect to utilization:

I – all kinds of utilization
II – curing
III – non-edible products

Only subjective methods are used for quality assessment in Brazilian fresh fish inspection. Guidelines for the fish inspector's organoleptic testing of fresh fish are included in the regulatory standards but the practical experience gained from many years of daily work with fish has proved to be much better than any written guidelines or official standards.

During in-plant inspection, the plant and personnel are checked and the fish are continuously inspected along the processing lines. When lots of fish or fishery products are shipped from one state to another or to a foreign country, they must obtain a certificate of inspection.

All District Laboratories (eight in all) have at least one chemist and a bacteriologist on the staff. At the present time these laboratories are concerned with the control of all products of animal origin, including fish, but they are not fisheries orientated. Bacteriological sections of the Laboratories check the sterility of canned fish but do not attempt to determine the type of bacteria present. Water supplies are analysed for the presence of coliforms (*Escherichia coli*) and total plate count (TPC). Frozen raw fish products are analysed for the same purpose: coliforms (*E. coli*) and TPC. With frozen cooked products, *Salmonella* and staphylococci coagulase-positive bacteria are checked. Only chemical examinations are carried out on cured fish and fish meal. Shellfish growing areas and shellfish are checked before an exportation certificate is given. The USA microbiological standards are used as a guideline in the absence of national standards.

To make steady and significant progress toward the achievement of stated objectives, annual goals are set to produce results within a given period of time. Target dates are fixed with this period not exceeding twelve months. Performance is measured against established criteria in order to define areas of difficulty and of low output. Goals may have to be modified if found to be unrealistic and unattainable within the restraints of time and cost. Alternatively, it may be discovered that progress within the reporting period consistently exceeds the goals set, making possible a more optimistic projection of future performance. At the moment the main criteria of performance which are employed by the Brazilian Fish Inspection Service are the following:

1. (1) Compliance by the processing industry with official or recommended standards of hygiene.
2. (2) A reduction in the quantity of raw material found unsuitable for marketing or processing.
3. (3) Fewer national and international consumer complaints about fish product quality.
4. (4) An increase in national per capita consumption of fish and fishery products.

Headquarters field supervisors routinely check all fish inspection district operations, inspecting the work of the fishery officers and the compliance by the processing industry with official and recommended standards of hygiene, labelling etc. Special compliance sheets are used for this purpose. This supervisory work is done by headquarters personnel and is of major importance in maintaining liaison, mutual understanding and criteria uniformity at the levels desired (Lima dos Santos, 1970).

## Staff recruitment and training of personnel

The staff of the Brazilian Fish Inspection Service is made up of 41 technically trained fish inspectors and 143 practically trained fish inspectors. The first group includes headquarters personnel and the district supervisors, and some of their assistants. According to Brazilian legislation all are veterinarians. The second group are responsible for direct inspection of the fish handling and processing establishments.

Veterinarians are submitted to a theoretical and practical training course at Rio Grande, the most complex and important Brazilian fish processing centre. The course has a duration of 45 days, covering fundamental aspects of fish spoilage, fish hygiene, handling and processing of fish and fishery products, quality assessment methods, sampling practice and the national regulations on fish and fishery products. The training is highly practical, including the identification of different fish species, main characteristics of fresh and spoiled fish and familiarization with the day-to-day problems of the fish industry and its inspection. This training is supplemented by (1) attendance at further special courses, (2) temporary postings to research and control laboratories and (3) participation in international co-operation.

The auxiliaries responsible for individual plants under the direction of veterinarians do not, at the moment, receive any formal training in fish inspection. Each supervisor is responsible for the training of his auxiliary personnel.

## Problems and deficiencies faced by the Fish Inspection Service

On its journey from the sea to the consumer, fish and fishery products are only inspected in Brazil at two points in the chain: the unloading, handling or processin plants and during transport. The fishing boats, distribution system and commerce are not inspected by the Federal Inspection System. The retailing level is under mandatory inspection by the Ministry of Health via the State Health and Municipal authorities, but the kind of inspection presently provided by them is highly unsatisfactory (McNeil, 1970).

The Brazilian Federal Fish Inspection Service understands that these two levels must also be covered by organized and rational efforts as soon as possible. Much of the progress made by the organized fish handling and processing industry is lost because of the lack of inspection in boats and at the retail level.

Being part of the National Department of Inspection of Products of Animal Origin, the Division of Inspection of Fish and Fishery Products has, in some regions, veterinarians responsible for a variety of processing plants and products. The same problem applies with the laboratory support. We think that this system presents great disadvantages to the activities of fish inspection and we already claim separate personnel for fisheries inspection (McNeill, 1970; Lima dos Santos, 1970 and 1971).

Inadequate support from the laboratories is one of the main difficulties faced by the Inspection Service. This problem will be very difficult to solve taking into account the limited available budget and the fixed attitude of the Departmental Headquarters against the existence of independent laboratories for the Fish Inspection branch (Boothby, 1968).

The need for better training methods to improve the technical and practical capacity of the fish inspectors is also an urgent problem to be solved. In this matter some very important progress has been made. A technical co-operative agreement was signed with Canada for the training of fish inspectors for the next 3 years, starting in July 1976. A Training Centre for Fish Inspectors will be built at Rio Grande with modern facilities for the teaching of fish technology, inspection and quality control.

## Conclusions

The view that no ready-made model of an inspection system could be directly applied to all countries was stated by a number of delegates present at the International Conference on Fish Inspection and Quality Control held in 1969 at Halifax, Canada. Brazil has its own model of a fish inspection system. It was initially based on the experience and organization of our traditional meat inspection system. However, it must be emphasized that significant progress toward the outlined objectives was made only after the implementation of a fisheries orientated philosophy within this basic model and after technical independence was obtained with the creation of a specific Division responsible for fish inspection in Brazil. Regarding these changes, two points were of importance: (1) the introduction of a specific staff and training programme in 1965 directed to fish technology, inspection and quality control and (2) effective action in the fields of technical assistance and education at all levels of activity, rather than performing almost exclusively sanitary police work.

Based upon Brazilian experience we have no doubts about the need and importance of a mandatory fish inspection system in countries that intend to develop their fishery industries. We believe that this system should be compulsory and that it must cover, when possible, the whole handling, processing and distribution chain, particularly in a tropical developing country. These countries often have a climate that makes the handling and preservation of fish difficult; frequently, there is a dearth of trained personnel and of basic resources (e.g. transport, electricity, good quality water, salt and ice); and more important, there may be a lack of awareness of health hazards and of modern sanitary practices. An organized and efficient fish inspection system can greatly change this picture if it is covered by a statutory legislation (Lima dos Santos, 1973).

In the last 10 years the Brazilian Fish Inspection Service has directly influenced or contributed to the following:

(1) Improved significantly the hygiene of the fish handling and processing environment, from gutting on the floor to the modern hygienic rooms of today.
(2) Improved the hygienic facilities for employees of the fish establishments e.g. toilets, showers and changing rooms.
(3) Increased and diversified the production of manufactured fish products by the introduction of new technology and equipment.
(4) Helped the fish industry to start, maintain and increase its export of fish products.
(5) Brought about a drop in numbers of complaints with regard to quality from importing countries and national consumers.
(6) Despite the recognized lack of an efficient national system for notification of food-borne diseases, there were no reported outbreaks of illness or death where fish were incriminated as the potential source of contamination.

However, we also recognize that many defects must be corrected and technical and administrative improvements should be made, particularly covering the following points:

(1) Enlarge and improve the laboratory support facilities.
(2) Improve the staff training programme.
(3) Improve end-product quality control methodology through the development of product standards and standardized methods of sampling and analysis.
(4) Be prepared to face the new problems of fish and shellfish contamination with chemicals, from water pollutants and the excessive use of food additives.
(5) Develop a national programme for fishing vessel inspection.

## References

**Boothby, G. F.** (1968) *Preliminary field report of fish processing and products improvement in Brazil.* Rio de Janeiro, Brazil: FAO, PDP 68/2.

**Lima dos Santos, C. A. M.** (1970) Conceituacao moderna da inspecao de pescado. Working paper presented at the 50th year of DIPOA. DIPOA. Ministry of Agriculture. Brasilia, Brazil.

**Lima dos Santos, C. A. M.** (1971) Report on status of Brazilian Fishing Industry. Country report presented to the I FAO/DANIDA Training course, Lyngby, Denmark.

**Lima dos Santos, C. A. M.** (1973) Particular problems of fish and shellfish hygiene in developing countries. Working paper prepared for the WHO Expert Committee on Food Hygiene (Fish and Shellfish Hygiene), Geneva, Switzerland.

**McNeill, R. J.** (1970) *Draft report on fish inspection and quality control in Brazil.* Rio de Janeiro, Brazil: FAO, SF 4/20 BRA 43.

# Keeping quality and freshness determination of *Sardinella aurita*

**A. Herzberg, Rachel Pasteur and Miriam Rosenblatt**
Ministry of Agriculture, Israel

## Summary

The storage life of iced *Sardinella aurita* is about 5 to 7 days. Covering the fish with a layer of crushed ice on board the fishing boat immediately after catch does not improve their apparent quality on arrival in the harbour but lengthens their storage life by 24 to 48 hours. The advantage of immediate icing at sea shows up after 2 to 3 days in cold storage when fish, iced without delay, are of better quality than fish iced only at unloading in the harbour.

The enzymatic hypoxanthine determination (Jones, 1964) gives better correlation (r=0.895) with sensory quality evaluation of *S. aurita* in the Eastern Mediterranean than either trimethylamine (r=0.544) or total volatile bases (r=0.502) determination.

Values of 2.0 $\mu$ mol hypoxanthine, and over, per gram of minced fish muscle indicate that the fish is not suitable for human consumption.

## Résumé

La durée de conservation de la *Sardinella aurita* gardée dans la glace est d'environ 5 à 7 jours. Le fait de recouvrir le poisson d'une couche de glace pilée à bord du bateau de pêche immédiatement après la prise n'améliore pas la qualité apparente du poisson à l'arrivée au port, mais allonge sa durée de conservation de 24 à 48 heures. L'avantage de la mise immédiate dans la glace à bord du bateau se manifeste après 2 à 3 jours de stockage en chambre froide car les poissons placés dans la glace immédiatement sont de meilleure qualité que ceux placés dans la glace au moment de leur débarquement au port.

La détermination enzymatique de l'hypoxanthine (Jones, 1964) donne une meilleure corrélation (r=0.895) avec l'évaluation sensorielle qualitative de *S. aurita* en Méditerranée Orientale que la détermination de la trimethylamine (r=0.544) ou des bases volatiles totales (r=0.502).

Les valeurs de 2.0 $\mu$ mol d'hypoxanthine, et au delà, par gramme de muscle de poisson haché indiquent que le poisson n'est pas apte à la consommation humaine.

## Resumen

La vida de almacenamiento de la *Sardinella aurita*, conservada en hielo, es de alrededor de 5 a 7 días. El cubrimiento del pescado con una capa de hielo machacado a bordo del barco pesquero inmediatamente despúes de la captura no mejora su calidad aparente a la llegada al puerto, pero alarga la vida de almacenamiento en 24 a 48 horas. Las ventajas del recubrimiento inmediato por hielo en el mar se manifiestan después de 2 a 3 días de almacenamiento en frío: el pescado cubierto de hielo sin demora es de mejor calidad que el pescado recubierto de hielo solamente en el momento de descarga en el puerto.

La enzimática determinación de hipoxantina (Jones, 1964) da mejor correlación (r=0.895) con la evaluación de calidad sensorial de *S. aurita* en al Mediterráneo Oriental, que la determinación de las bases volátiles totales (r=0.502) o la trimetilamina (r=0.544).

Los valores de 2.0 $\mu$ mol de hipoxantina, o superiores, por gramo de músculo de pescado triturado indican, que éste no es adecuado para el consumo humano.

## Introduction

*Sardinella aurita* is the most important fish from the local catch in the Israeli canning industry; by far the major part of the pelagic catch belongs to this species, small quantities of *Sardinella maderensis* and *Dussumieria productissima* are caught as well, and are recorded in the statistics, together with *S. aurita* as 'sardines'.

TABLE 1. *Chemical composition of* S. aurita

| *Source* | *Protein* % | *Oil* % | *Ash* % | *Water* % |
|---|---|---|---|---|
| Milone (1896) | 17.2 | 0.5–4.9 | 1.0 | 78.7 |
| Tulsner (1965) | 18.0–21.6 | 2.3–17.0 | 0.7–2.6 | 68.0–76.0 |
| Herzberg & Pasteur (1969) | 17.0–22.3 | 0.4–20.0 | 1.4–2.9 | 69.9–78.1 |

Quantities caught in Israel during the last few years were 900 tons for 1974, 1,600 tons for 1973 and 1,900 tons for 1972 (Sarid, 1975).

The biology of this species is summarized by Ben-Tuvia (1960). It is a widespread species, found off western Africa and Brazil, where it reaches a total length of up to 35 cm. Catches for 1972 included 132,000 tons for Brazil, 142,000 tons in the SE Atlantic (Angola) and 643,000 tons in the eastern central Atlantic (FAO, 1972). In the Israeli catch in the eastern Mediterranean, like most other fish, it is smaller and reaches a size of up to 18–20 cm total length. The fat content and chemical composition, which are important to the canning industry, have been described for western Africa by Tulsner (1965), for the Italian catch by Milone (1896), for the eastern Mediterranean by El Saby (1973) and by Herzberg and Pasteur (1969). The chemical composition is summarized in Table 1.

The purpose of this work was twofold: first to determine how long *S. aurita* can be kept under ice in a fresh, edible and acceptable condition for the canning industry; and second, to find an objective chemical method for freshness determination which is parallel to the evaluation of quality according to flavour, taste, texture and general appearance of these fish at different stages of storage.

Doubts about freshness of fish stem from two sources:

(a) Quality is not necessarily good or bad; freshness of any fish changes from excellent towards rejection through many intermediate steps.

(b) Consumers and potential buyers do not necessarily agree on the degree of freshness or spoilage. A fish may well be fresh and acceptable to one person and spoiled and rejected by another. Therefore a chemical method is needed; one compound (trimethylamine, hypoxanthine) or a complex of substances (total volatile bases) is measured.

## Materials and methods

### *Taking the fish samples*

Fish were brought to the laboratory during the period June 1972–September 1973. They were bought at the wholesale fish auction in the Kishon harbour on the day after capture. In every case 'storage age' was recorded. The fish were covered with ice either in the harbour or upon arrival at the laboratory, about one half hour later. In one trial, some of the fish were iced on board immediately after capture and some after arrival in the laboratory. The fish were kept in ice in plastic containers with holes in the bottom, which were put into another plastic box for draining and kept under refrigeration at 4°C or in an insulated box without refrigeration. Fish of different sizes, at different seasons and from various fishing vessels were used in order to obtain results reasonably representative of the average commercial catch.

### *Preparation of the samples*

Samples of 5–6 small fish or 2 medium to large fish were analyzed regularly for a period of up to 11 days. The fish were scaled, gutted, headed and cleaned, the rump was sliced into one inch pieces, from which, after being mixed, samples were taken for organoleptic and chemical tests.

### *Sensory estimation*

The sensory estimation was carried out by laboratory staff, (3 to 4 people). The samples were first judged on account of their colour, odour, firmness of the flesh and general appearance, and, after being kept for 35 minutes in a closed petri dish over boiling water, they were tasted for flavour, odour and texture. Marks were given according to a 5-point scale (Table 2).

TABLE 2. *Organoleptic rating of the samples*

| Mark | Evaluation |
|---|---|
| 5 | Completely fresh, very good to excellent |
| 4 | Fair to good |
| 3 | Some off-flavour, slightly rancid, still acceptable |
| 2 | Marginal, almost spoiled, rancid |
| 1 | Bad, spoiled, rejectable |

### *Chemical methods*

Three chemical methods for freshness determination have been used and compared to the sensory evaluation made by the laboratory workers. Total volatile bases (TVB), as described by the Israel Standards Institute, were determined on samples of 10 grams; trimethylamine (TMA) as determined by Dyer (1959) and hypoxanthine (Hx) estimated as uric acid, as described by Jones (1964), were determined on samples of 25 grams each.

## Results

Development of TMA, Hx and TVB in comparison to the sensory evaluation of *S. aurita* was followed in seven experiments, conducted during June–July 1972, October 1972 and during April, June and September 1973. Results are shown in Figures 1 to 7.

### *Influence of fish size*

Differences between size groups are noticed in TMA development and to a lesser degree also in Hx and TVB. There is, however, no constant relationship between these parameters and fish size, as in experiment no. 1 the small fish show less TMA than the large ones but approximately equal Hx and sensory evaluation (Figure 1) whereas in experiment no. 3 medium sized fish show less TMA and Hx than the small ones but more TVB; sensory evaluation in this case indicates a slightly better quality of the medium sized fish (Figure 3).

### *Influence of ice*

The influence of early icing was shown in experiment no. 4 which was the repeat of a previous field test made without subsequent chemical freshness determination. On arrival at the harbour, both lots of fish, iced or un-iced at sea, looked alike to laboratory workers as well as to fishermen and buyers. Soon afterwards, in the laboratory, a difference was noted both by chemical and sensory tests. TMA as well as Hx and TVB values were higher for un-iced than for iced fish during subsequent storage in ice, and these results were confirmed by the organoleptic tests made on the same samples (Figure 4). Fish which had not been iced at sea were stale at 4 days and completely spoiled after 6 days whereas fish iced at sea were still acceptable at 4 days and stale to spoiled at 6 days. This showed that covering the fish with ice as early as possible lengthened its storage life by one to two days.

Experiment no. 7 was made at suboptimal storage conditions so as to be more representative of commercial practice. In spite of the fact that the fish were in prime condition at the beginning of the trial, they spoiled more rapidly (during 4–5 days) not being kept constantly under a layer of ice (Figure 7).

### *Parameters of fish deterioration*

*Trimethylamine (TMA)*: TMA values for fresh fish ranged from 0.2–1.5 mg/100 g and for unacceptable fish between 1.2–2.8 mg/100 g (Figure 8) with the exception of one lot of fish (TL 15.0–22.5 cm) which showed a high TMA content from the third day of storage (Figure 1). Although the averages of the different trials show a steady linear increase in TMA content corresponding to the samples as measured by organoleptic evaluation (Figure 8), a closer look at the different trials shows that, initially, fluctuations of TMA content occur during storage (Figures 1, 2, 3, 5 and 7) and that during the final stage of storage (near spoilage) a decrease in TMA is liable to occur.

As stated before, fish size apparently has some bearing on TMA content (Figures 1 and 3) and the differences in TMA between fresh and spoiled fish are not very great and sometimes even overlap in the range of 0.4–2.0 mg TMA/100 g fish. The region of no overlap was below 0.4 mg/100 g for fresh and above 2.0 mg/100 g for stale fish, as shown in Figure 8.

*Total volatile bases (TVB)*: A slight overall increase in TVB content occurred during storage of fish on ice. However, TVB values ranged from 22.5 mg/100 g to 30 mg/100 g for fresh fish as well as for spoiled fish (Figure 9). This overlap stems from the fact that TVB values do not increase gradually during storage on ice but fluctuate without apparent connection to fish deterioration. In some trials, the initial value of TVB was even higher than its value during subsequent storage and, in several cases, it went down during the last days although the fish were almost completely spoiled (Figures 4, 6 and 7).

*Hypoxanthine (Hx)*: The gradual accumulation of Hx during storage on ice was followed for up to 11 days. Fresh fish contained up to 1.4 micromole Hx per gram of minced fish muscle. Values of 1.5–2.0 $\mu$ mol/g indicated doubtful quality, and more than 2.0 $\mu$ mol/g was found in spoiled to inedible fish. This is demonstrated clearly in Figure 10, which shows also, that hardly any overlap occurs in the values between mark 4 ('Good to fair') and mark 2 ('Marginal, almost spoiled, rancid') of the organoleptic rating (Table 2), whereas mark 3 ('Some off-flavour, slightly rancid, still acceptable') rates in between.

## Discussion and conclusions

Regression lines of TMA, TVB and Hx on organoleptic scores are drawn in Figures 8, 9 and 10 respectively. A low correlation coefficient (r) was calculated for TMA (r=–0.533) as well as for TVB (r=–0.567). A greater correlation was found for Hx (r=–0.876) which shows that this parameter should be preferred to both TMA TVB for objective freshness determination of *S. aurita.*

Values of 2.0 micromoles Hx, and over, per gram of fish muscle, indicate that the fish is not suitable for human consumption either fresh or as a canned product.

The shelf life of *S. aurita* kept on ice in cold storage ranges from about 5 to 7 days. The trip from the fishing grounds to the harbour takes a few hours only and the catch generally arrives in a reasonable state of freshness. Covering the fish with a layer of crushed ice on board the fishing vessel, immediately after capture, lengthens its storage life by 24 to 48 hours. although it does not improve its apparent quality on arrival. The advantage of icing the fish at sea immediately after capture shows up clearly after they are kept for 2 to 3 days in cold storage when fish iced at sea look definitely more fresh than fish from the same catch which were iced only at unloading in the harbour.

## Acknowledgement

Thanks are due to Mr S. Pisanty of the Fishery Technology Unit for his help in the statistical analysis of the results.

**Figure 1**

**Changes in TMA, Hx and organoleptic rating of two size groups of *S. aurita* during storage in ice (Experiment 1)**

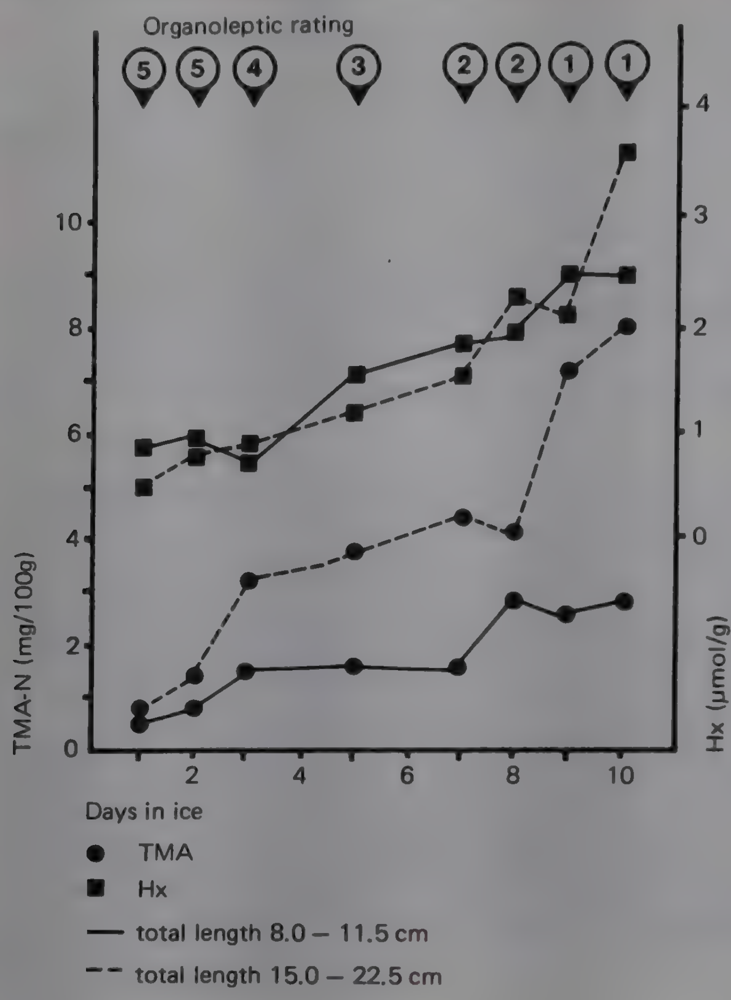


**Figure 2**

**Changes in TMA, Hx and organoleptic rating of muscle of *S. aurita* during storage in ice (Experiment 2)**

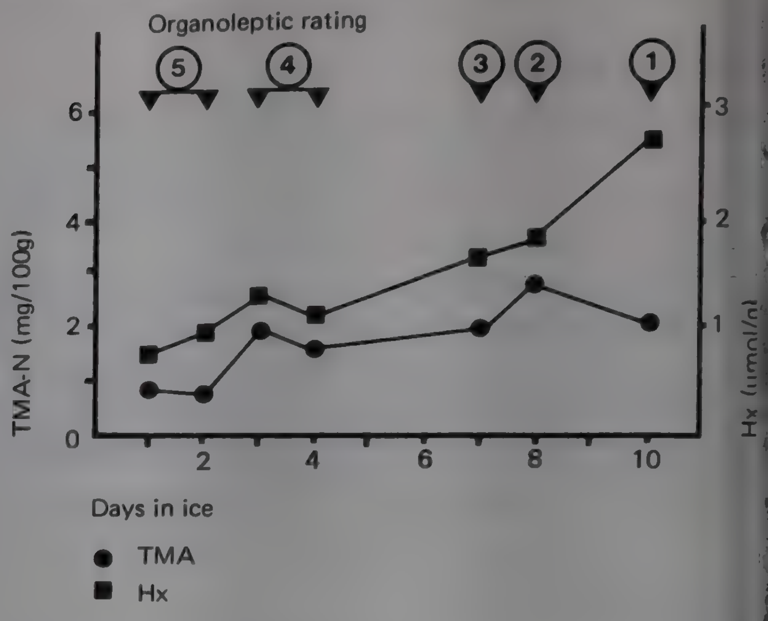


**Figure 3**

**Changes in TMA, Hx, TVB and organoleptic rating of muscle from two size groups of *S. aurita* during storage in ice (Experiment 3)**

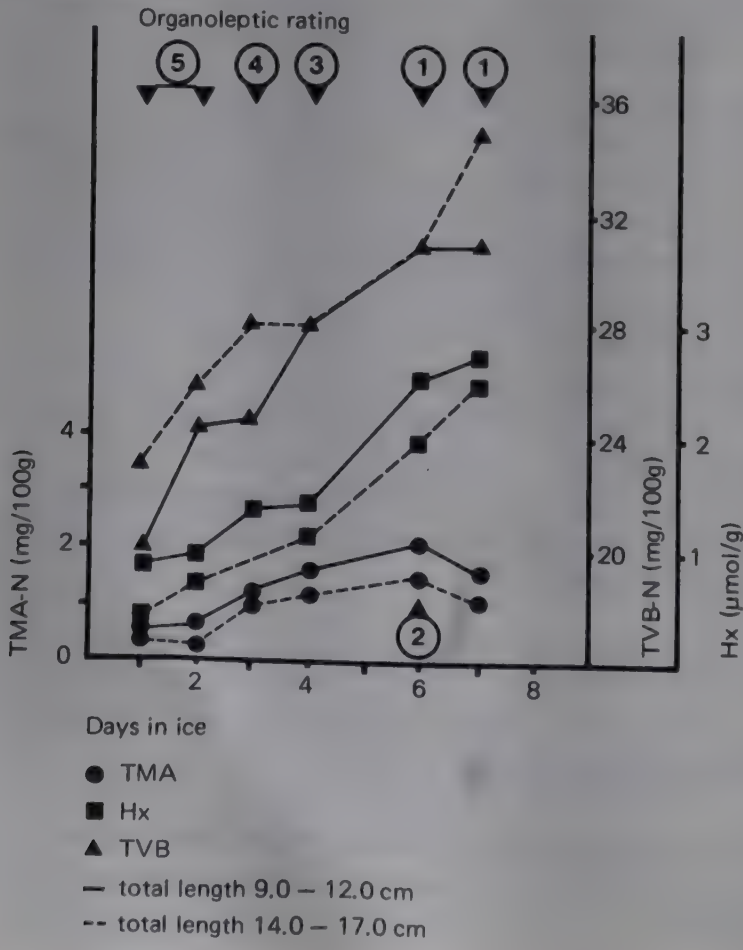


**Figure 4**

**Changes in TMA, Hx, TVB and organoleptic rating of muscle of *S. aurita** during storage in ice (Experiment 4)**

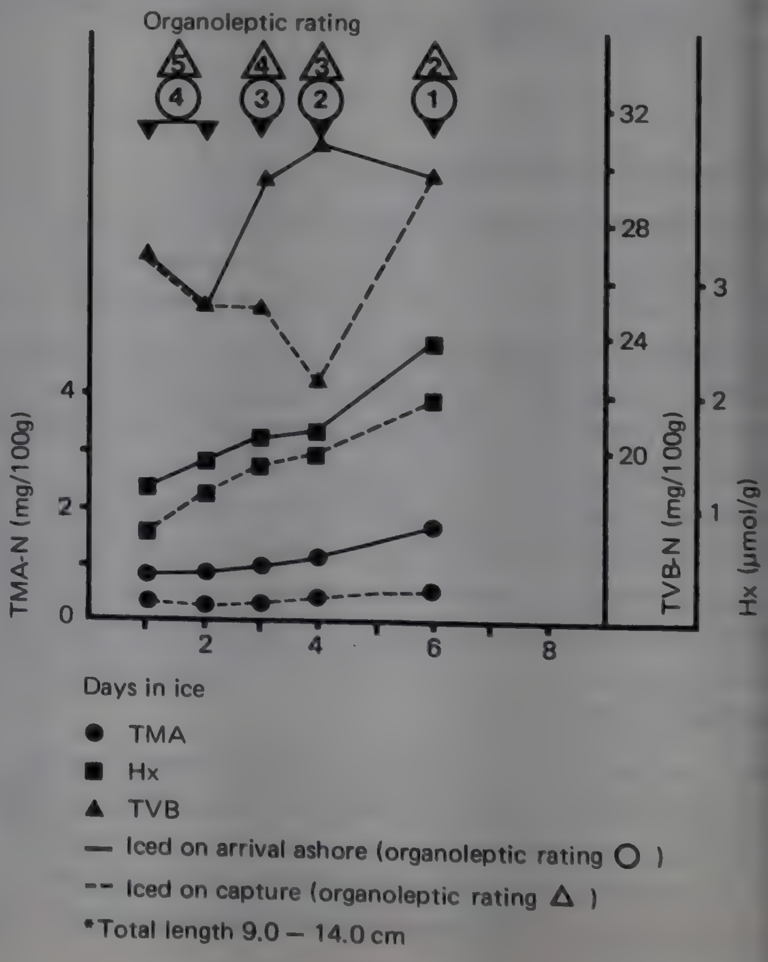
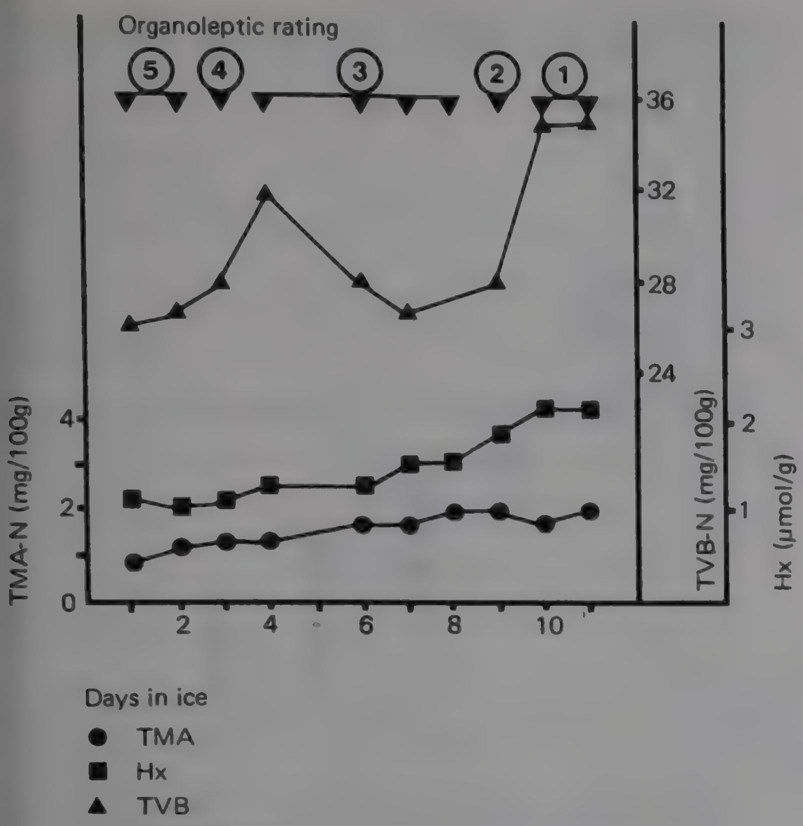
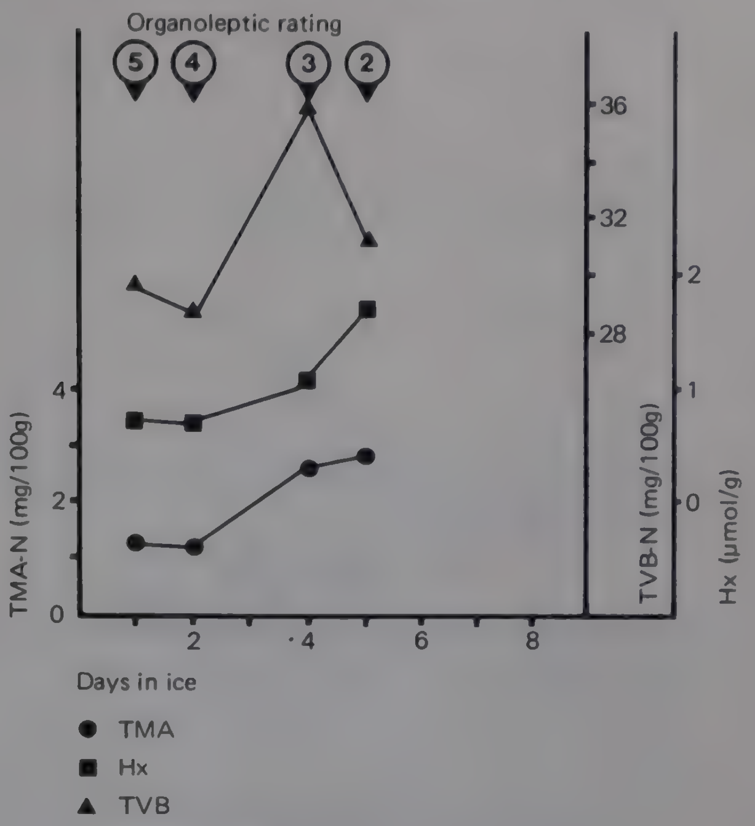


**Figure 5**
Changes in TMA, Hx, TVB and organoleptic rating of muscle of *S. aurita** during storage in ice (Experiment 5)



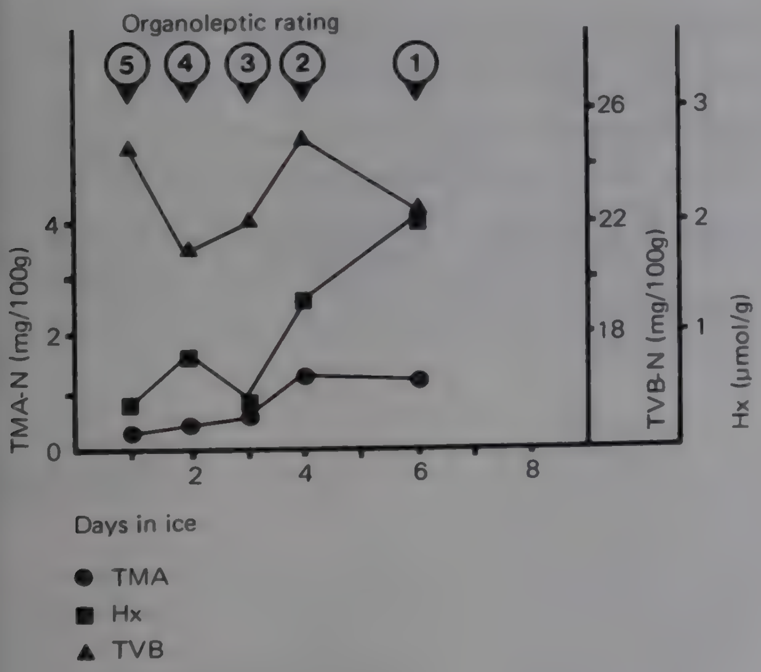
*Total length 10.0 – 17.0 cm

**Figure 6**
Changes in TMA, Hx, TVB and organoleptic rating of muscle of *S. aurita** during storage in ice (Experiment 6)



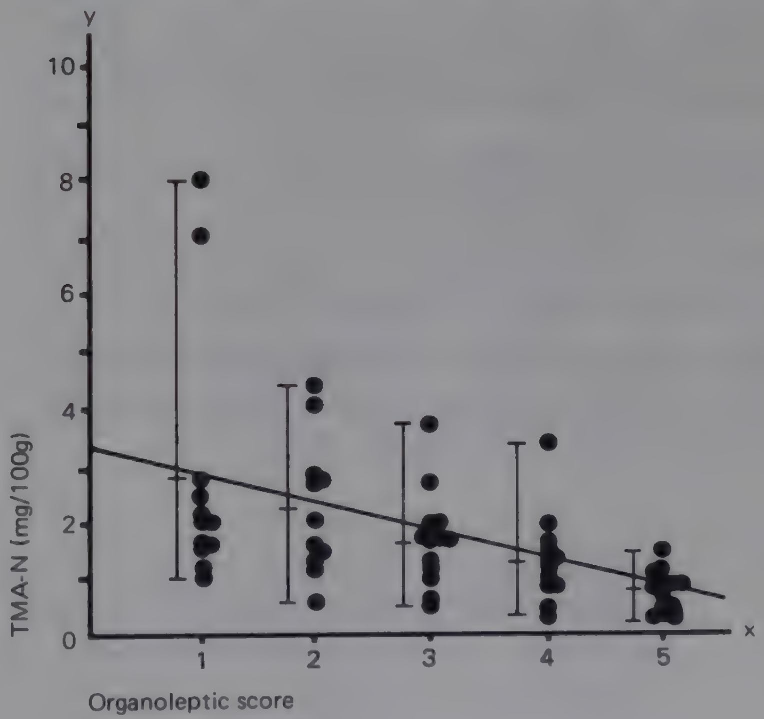
*Total length 18.0 – 20.0 cm

**Figure 7**
Changes in TMA, Hx, TVB and organoleptic rating of muscle of *S. aurita** during storage in ice under suboptimal conditions (Experiment 7)



*Total length 13.0 – 16.0 cm

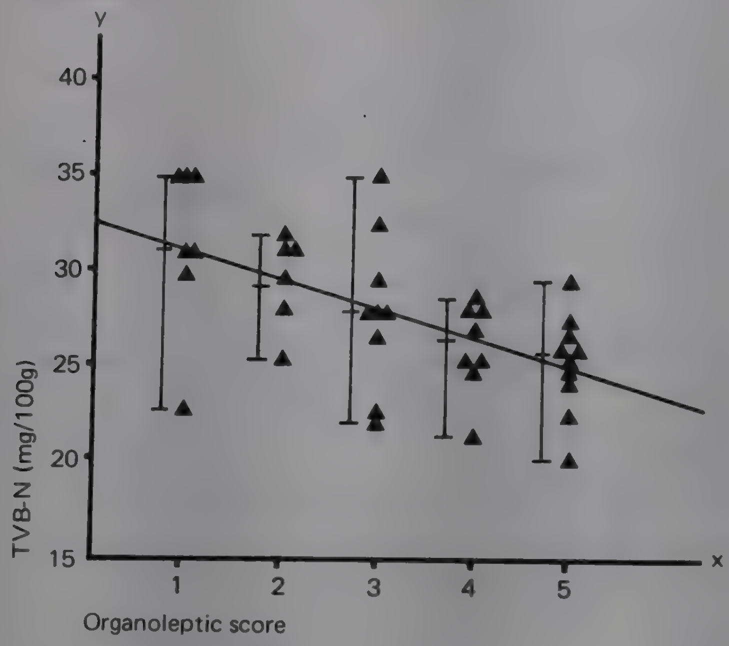
**Figure 8**
Correlation between TMA content and organoleptic rating of *S. aurita*



$y = 3.296 - 0.518\,x$

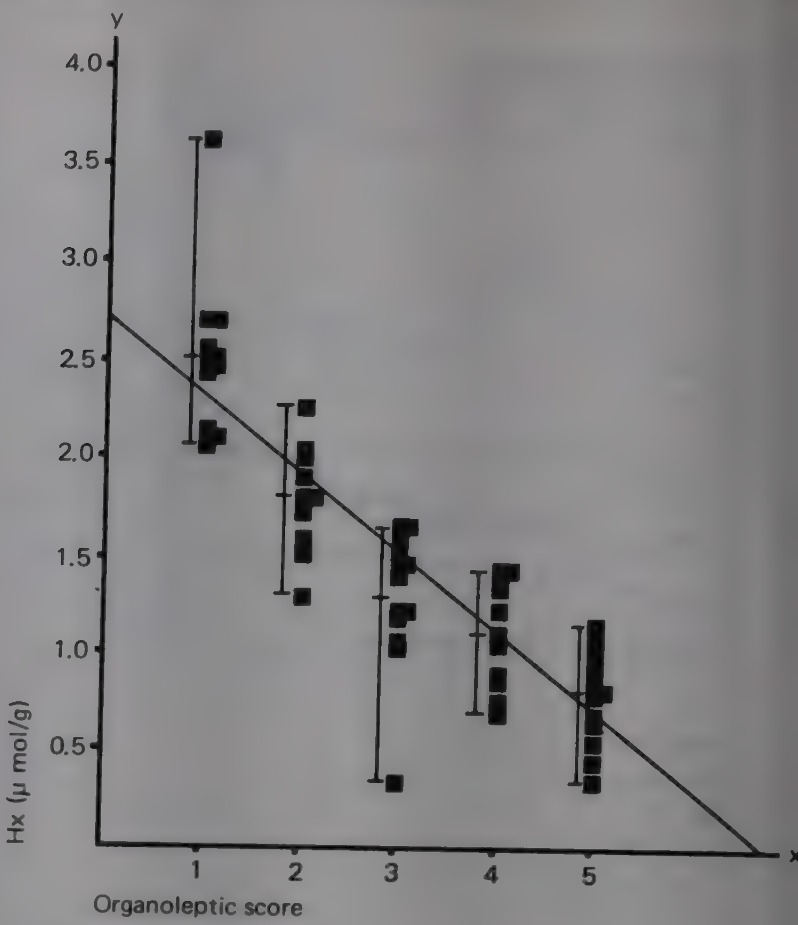
$r = -0.533$

**Figure 9**
**Correlation between TVB content and organoleptic rating of *S. aurita***



$y = 32.55 - 1.55\,x$
$r = -0.567$

**Figure 10**
**Correlation between Hx content and organoleptic rating of *S. aurita***



$y = 2.707 - 0.399\,x$
$r = -0.876$

## References

**Ben-Tuvia, A.** (1960) Synopsis of biological data on *Sardinella aurita* of the Mediterranean Sea and other waters. *FAO Fish. Biol. Synop.* No. 14. This originally appeared in: *Proceedings of the World Scientific Meeting on the Biology of Sardines and Related Species, Rome,* 14–21 September 1959, Rosa, H. and Murphy, G. Volume 2, Species Synopsis No. 9, pp. 287–312.

**Dyer, W. J.** (1959) Report on trimethylamine in fish. *Assoc. Off. Agric. Chem.* 42, 292–294.

**El Saby, M. K.** (1973) *Notes and Memoires, Hydrobiology and Fisheries Directorate, Cairo* 28, 1.

**Herzberg, A. and Pasteur, R.** (1969) Proximate composition of commercial fishes from the Mediterranean Sea and the Red Sea. *Fish. Ind. Res.* 5, (2), 39–65.

**Jones, N. R., Murray, J., Livingston, E. I. and Murray, C. K.** (1964) Rapid estimations of hypoxanthine concentrations as indices of the freshness of chill-stored fish. *J. Sci. Food Agric.* 15, 763–774.

**Milone, U.** (1896) Composizione valore nutritive ed assimilabilita della carne muscolare dei pesci. *Bollettino della Societa dei Naturalisti i Napoli* 10, 311–394.

**Sarid, Z.** (1975) *Israel fisheries in figures.* Haifa, Israel: Ministry of Agriculture, Department of Fisheries.

**Standards Institute of Israel** (1976) Sardines, fresh, for industrial processing. *Israel Standard No. 516.* Tel Aviv.

**Tulsner, M.** (1965) Die technologischen eigenschaften und die möglichkeiten der verarbeitung der wichtigsten Nordwestafrikanischen nutzfischarten. *Fischereiforsch.* 3 (1), 55–63.

# Some technological characteristics of hake from South American waters

**H. H. Huss**
Ministry of Fisheries, Denmark
and
**I. Asenjo**
Instituto de Fomento Pesquero, Chile

## Summary

The cool waters surrounding the southern part of South America are rich in fish and contain at least 3 of the 11 nominal hake species. The storage life of the hake species has been studied and the significance of various factors affecting quality and keeping time has been assessed. While rapid spoilage was observed in ungutted Peruvian hake, both gutted and ungutted Chilean and Argentinean hake retained a good organoleptic quality for one week and a total edible keeping time for up to 11 days when stored in ice or chilled sea water (CSW). The soft texture of the hake flesh, the spoilage pattern and the very nature of the hake fishery favour the CSW method.

## Résumé

Les eaux fraiches entourant la partie sud de l'Amérique du Sud sont riches en poisson et contiennent au moins 3 des 11 espèces dénommées de merlu. La durée de conservation des espèces de requins a été étudiée et la signification des divers facteurs affectant la qualité et le temps de conservation ont été déterminés. Alors qu'une détérioration rapide était observée chez les merlus péruviens non vidés, les merlus chiliens et argentins non vidés et vidés ont gardé une bonne qualité organoleptique pendant une semaine et une durée totale de conservation et d'aptitude à la consommation atteignant 11 jours lorsqu'ils étaient gardés dans de la glace ou dans de l'eau de mer glacée (CSW). La consistance molle de la chair de requin, le processus de détérioration et la nature même de la pêche au merlu favorisent la méthode par CSW.

## Resumen

Las aguas frías que rodean la parte meridonal de América del Sur son ricas en pesca y contienen al menos 3 de las 11 especies nominales de merluza. Se ha estudiado la vida de almacenamiento de las especies de merluza y se ha valorado la significación de varios factores que afectan a la calidad y tiempo de conservación. Al mismo tiempo que se observó un rápido deterioro en la merluza peruana sin destripar, tanto la merluza limpia como la no limpia chilena y argentina conservaba una buena calidad organoléptica durante una semana, y un tiempo total de conservación como comestible de hasta 11 días cuando se conservaba en hielo o agua del mar enfriada (CSW). La textura blanda de la carne de merluza, la forma de deteriorarse y la propia naturaleza de la pesca de la merluza favorecen el método CSW.

## Introduction

At least three different species of fish belonging to the genus *Merluccius* are found in the cool waters surrounding the southern coastline of South America. A species known as 'merluza de cola' (*Macroronus magellanicus*), which is very similar to the *Merluccius*, is also found.

Merluza de cola and *M. polylepsis*, also called *Micromesistius australis* (Gulland, 1971), are only found south of latitude 40°S. These species are not fished at present and the size of the resources is not known.

On the continental shelf of the south-west Atlantic extending from about latitude 30°S off southern Brazil and to the Straits of Magellan (Grinols and Tillman, 1970) there is a rich resource of Patagonian hake (*Merluccius merluccius hubbsi*). Lack of infrastructure and inadequate technology have limited the fishing to the northern Argentine continental shelf. In the south-east Pacific the Chilean hake (*Merluccius gayi*) and Peruvian hake (*M. gayi var. peruani*) are found along the coastline from the Straits of Magellan to the northern border of Peru at about 4°S. There are, however, two distinct areas of distribution, found in central and southern Chile and northern Peru.

The hake is a lean cod-like demersal fish species with a white and rather soft flesh. The growth rate and length of fish vary with the latitude. Mature 3 to 4 year Chilean hake are 38 to 46 cm long (Aguayo, 1971), but fish are shorter towards the north. The fish are caught by hand-line or bottom trawling.

The South American hake resources are at present not fully utilized as shown in Table 1. Furthermore the quality of the landed hake is very poor and a large proportion is utilized only for the production of fish meal.

TABLE 1. *Exploitation of hake from South American waters (tonnes)*

| | *Potential catch (Gulland, 1971)* | *Catch in 1973 (FAO, 1974)* |
|---|---|---|
| Argentine<br>Uruguay | 1,500,000 | 151,400 |
| Chile | 130,000 | 46,500 |
| Peru | 60,000 | 13,400 |

Although a very good food fish and recognized as a 'cod substitute' on the world market, the merluza is traditionally regarded by the local fishermen and consumers as a trash fish. With the shortage of protein, not only on a local but also on a world level, this is an intolerable situation. Substantial work has recently been published on the properties of Cape hake (Burt, 1974, Burt *et al.*, 1974a, Burt *et al.*, 1974b) and Pacific hake (Dassow and Beardsley, 1974), but little information is available on the characteristics of hake from South American waters (Andersen *et al.*, 1974). Consequently within the framework of local FAO projects, studies have been carried out in order to evaluate the technological characteristics of the hake species with the aim o improving the quality of the landed fish. Most studies have been carried out as storage trials, and throughout the various experiments, the quality of the raw and cooked fish has been assessed by newly trained panels of 6 to 8 members. A hedonic scale, as shown in Table 2 has been used in the assessments.

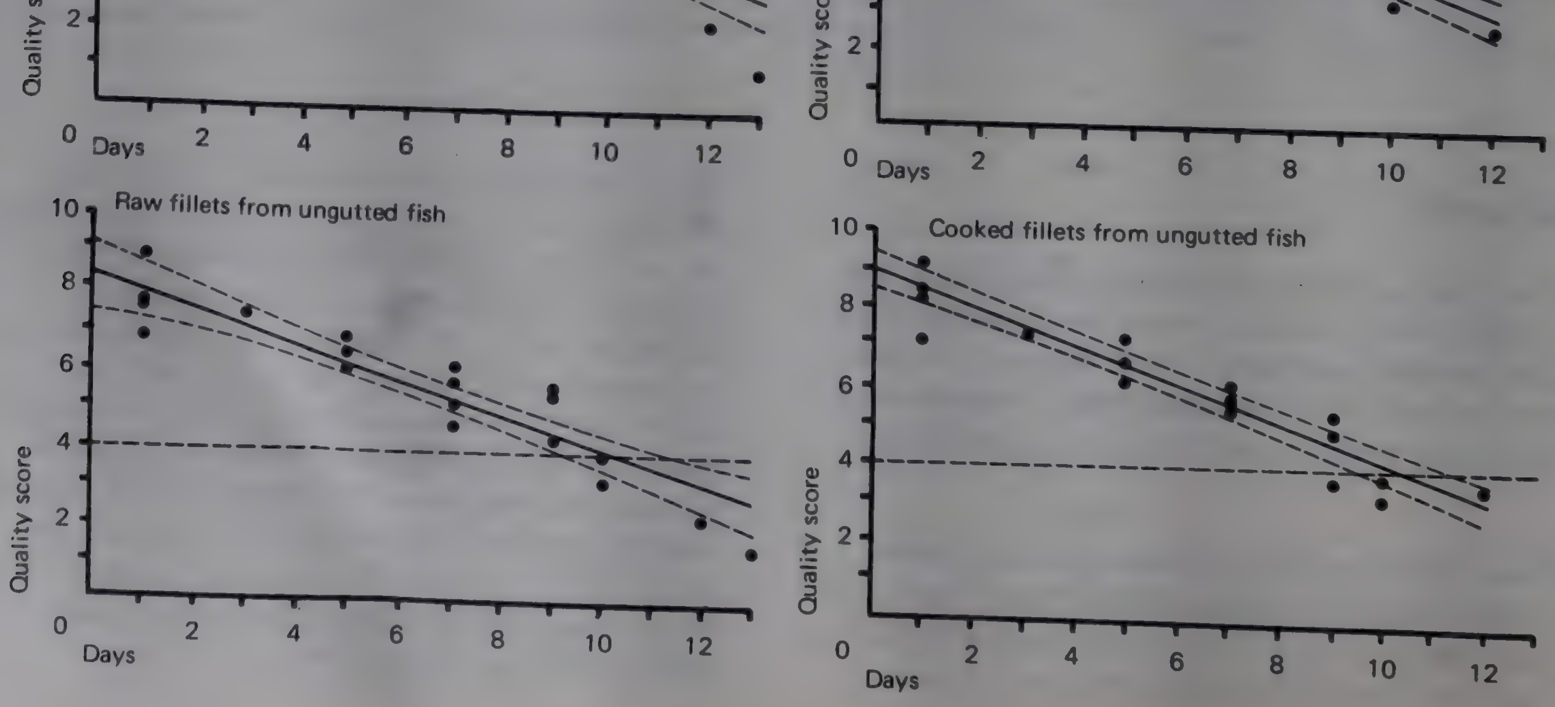
TABLE 2. *Hedonic scores used in the organoleptic assessment of raw and cooked hake samples.*

| *Score* | *Characteristic of sample* |
|---|---|
| 10 | Ideal |
| 8 | Good |
| 6 | Fair |
| 4 | Just acceptable |
| 2 | Poor |
| 0 | Very poor |

In the same studies the organoleptic assessment has been supported by chemical and bacteriological analyses.

**Figure 1**

**Organoleptic assessment of Chilean hake stored in ice. Regression lines and 95% confidence intervals of means are shown. Individual points are means of four storage experiments carried out in February, May, August and November.**



## *Chilean hake (Merluccius gayi)*

The flesh of Chilean hake is similar to most hake species and is very soft in texture. Abnormally soft flesh, due to the presence of a microscopic microsporidian parasite, does not, however, constitute a serious problem in Chile as in many other hake fisheries (Dassow *et al.*, 1970). The colour of the flesh varies from grey-white to pink, but discolorations are frequent. The delicate nature of the flesh renders it susceptible to bruise marks and surface fat may easily be oxidized causing brownish discolorations.

The odour and flavour of good quality cooked Chilean hake is neutral or non specific. Cooked flesh which is moist, tender and flaky with a pleasant desirable flavour, is characteristic only of the very fresh fish.

The spoilage of wet fish results in the development of staleness, soft texture, strong off-odours and off-flavours and occasionally rancidity. The accumulation of volatile bases above 20 mg N/100 g flesh is associated only with stale or spoiled fish.

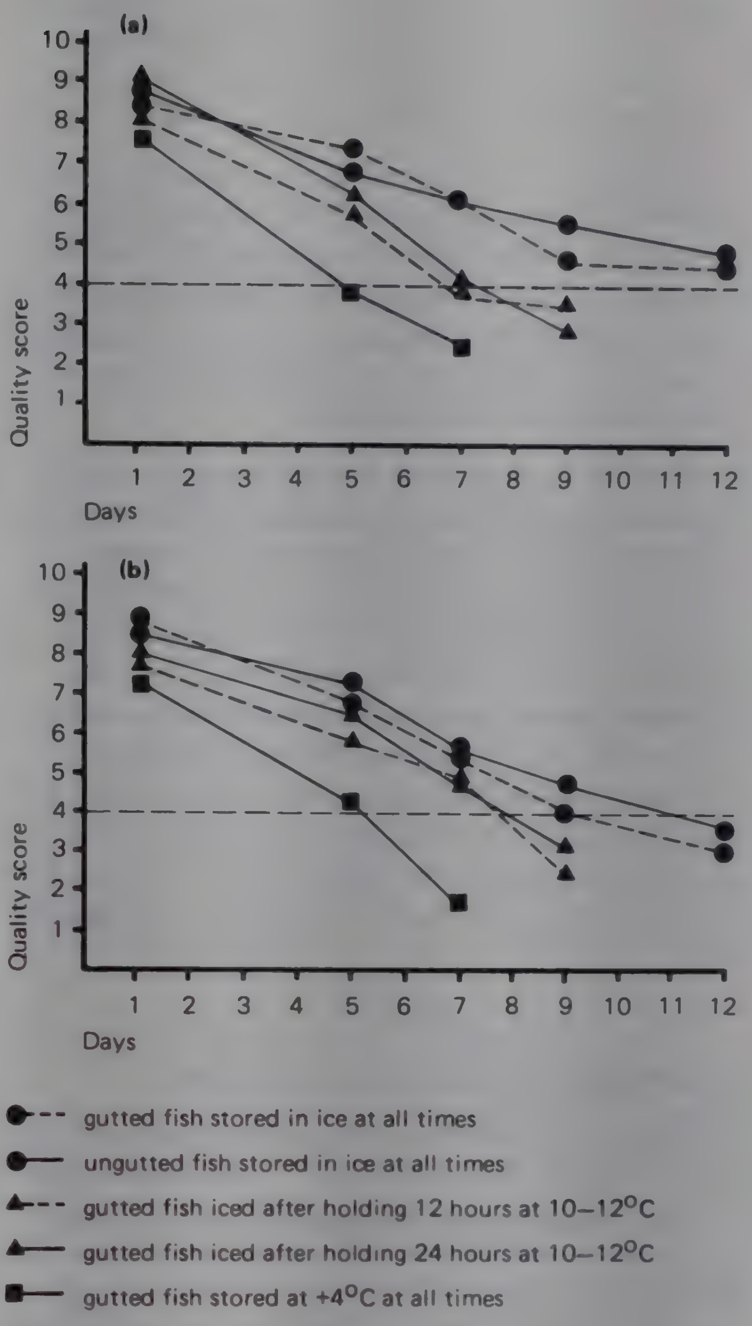
The significance of various factors affecting the quality and total keeping time of Chilean hake has been assessed in a series of experimental studies which are described below.

*Gutting:* Experimental material was collected on board commercial trawlers after trawling for periods of 1 to 2 hours. The fish were carefully handled at all times to avoid bruising. The gutted and ungutted fish were chilled and stored in ice or chilled sea water (CSW) at 0°C. Samples were taken at intervals during storage for quality assessment. The differences in quality between samples from gutted and ungutted fish were slight and insignificant, clearly demonstrating that gutting does not improve quality and keeping time of the stored fish, as shown in Figure 1. The normal keeping time in ice for gutted and ungutted fish is 9 to 11 days. In both groups of fish the texture of the flesh was found to be soft and discolorations were frequent. Pink fillets and blood discolorations, as well as a special greenish discoloration of the abdominal wall, which is related to autolytic changes developing from the gut, are often seen in both groups of fillets. The latter type of discoloration appears in fillets from gutted fish because traditional hand gutting does not remove all of the upper digestive tract. In addition, the brown discoloration caused by the oxidation of surface fat is seen only in fillets from gutted fish. Brown discolorations of the cut surfaces of headed and gutted fish stored in ice were seen the day after capture. However, these discolorations were never very pronounced and the overall rating of the raw fillet equalled that of fillets cut from head-on gutted and ungutted fish.

*Temperature:* While the influence of gutting is not significant, our studies have confirmed that the storage temperature is by far the most important factor affecting quality and keeping time of fish. Delay in chilling on board, or storage at temperatures only a few degrees above 0°C, lead to a dramatic loss of quality and a substantial reduction of the keeping time, as shown in Figure 2.

**Figure 2**

**Organoleptic assessment of a) raw and b) cooked hake fillets cut from fish stored under different conditions.**



The method of chilling is of minor importance. Although ice is the obvious cooling medium at present, some trials using chilled sea water (CSW) have been carried out in order to evaluate this method for use in the Chilean hake fishery. Steel tanks, filled with a mixture of ice and sea water and without any air circulation, were used in the experimental work. Although strong hydrogen sulphide odours developed in chilled sea water containing ungutted hake, the same keeping time as seen in ice (10 to 11 days) was found for gutted and ungutted merluza stored in CSW at 0°C. A small salt uptake (from 0.4 to 0.9%) was seen in CSW fish but this salt uptake was not detectable organoleptically. Also the moisture content increased (from 82 to 84%) and although the penetration of salt is reported to cause the flesh to be firmer (Burt, 1974), the overall impression in our work was a slightly softer texture of CSW chilled fish. Later trials, however, indicated that the fish flesh remained more cohesive in CSW chilled fish than in iced fish.

Machine filleting and skinning of the whole fish after one week of storage in CSW and ice resulted in more than 80% and less than 40% intact fillets respectively (Peterson and Feldstedt, 1975). Due to the anaerobic conditions the brown discolorations of gutted hake were completely eliminated by this method of chill storage.

### *Argentinean or Patagonian hake (Merluccius merluccius hubbsi)*

The Patagonian hake also has a very soft and fragile texture. An abnormally soft texture due to infestation with chloromyxum was originally a limiting factor in the development of this fishery (Grinols, 1970). The present situation is not known by the authors.

The appearance of the raw fillets, as well as the odour and flavour of raw and cooked fillet, are very much as described for Chilean hake. Many discolorations are likely to occur due to the autolytic changes developing from the gut, bad bleeding and rough physical handling. Pronounced brownish discolorations due to oxidation rapidly develop on all cut surfaces.

The shelf life of gutted and carefully handled fish was found to be 9 to 10 days in ice (Huss, 1971); ungutted fish deteriorated in less than one week. The reason for early rejection was the development of serious discoloration in the belly area, increased softness of the flesh and an offensive cabbage-like odour. In a later experiment, when samples of fillets were presented on the fresh fish market in Buenos Aires, a panel of 35 wholesalers and retailers rated fillets from gutted fish lower than fillets from ungutted fish due to extensive brown discolorations. Obviously more work is needed to establish whether or not it is desirable to gut this fish at sea.

### *Peruvian hake (Merluccius gayi var. peruanus)*

Only limited information on the technological characteristics of Peruvian hake is available. A small-scale and not very sophisticated experiment carried out in Northern Peru revealed considerable differences from Chilean hake. The shelf life of gutted Peruvian hake kept in ice was estimated to be less than one week, and strong offensive and unacceptable cauliflower-like odours were noticed in ungutted iced fish after only 2 days of storage. This is in agreement with the observations reported by Halgaard (1973), who estimated the edible shelf life of iced gutted fish to be one week, and that of ungutted fish to be 3 to 4 days. Soft and abnormal texture due to the presence of myxosporidia constitutes a serious problem in the Peruvian hake fishery. 134 fish or fillets were sampled because of their thin and flabby appearance. These fish were tested for myxoporida and about 50% were infected (Halgaard, 1973).

The proximate chemical composition of South American hake is listed in Table 3.

## Quality of frozen hake

Information on the storage life of frozen South American hake is of considerable interest, as optimal utilization of this resource involves marketing of frozen fillets or blocks. Unfortunately only limited and non-conclusive data are available. All types of fish undergo changes in odour and flavour during cold storage. In addition to the normal changes observed in the white fleshed fish, the very labile surface fat in merluza is likely to become rancid, resulting in brown discoloration during frozen storage.

In our studies, the shelf life of the frozen products has been evaluated by means of an organoleptic assessment of the frozen blocks of fillets and of the thawed cooked fillets.

Individually quick frozen (IQF) fillets, produced from good quality Chilean hake (one day in ice), were acceptable after 6 weeks of storage at –15°C. For prolonged storage the fillets needed to be protected by a layer of glaze or by tight packaging in films impermeable to oxygen and moisture. Protected in this way the fillets were acceptable for up to 5 months.

During storage tests of frozen blocks held at –15°C and –25°C the texture and flavour of the lean flesh showed few adverse changes during the first three months, but rancidity developed in fillets exposed to air. During prolonged cold storage the fillets became dry, fibrous and rather tasteless. When good quality raw material (one day on ice) was used the blocks were still acceptable after storage in still air (–15°C and –25°C) for 6 months; when the experiment terminated. Blocks prepared from fish stored one week in ice were rejected after 4–5 months of cold storage at these temperatures (Figure 3). 'Foreign' or 'strange' odour and flavour possibly related to 'cold storage odour and flavour' as described by McGill *et al.* (1974) were noticed in some samples. The results indicate that chill storage before freezing should be limited to one week.

Contrary to this it was found that fillet blocks from good quality Argentinean hake (4 days in ice) were rejected after one month of frozen storage at –20 ±2°C (Huss, 1971). The texture of the thawed sample was extremely soft and mushy and the fillets had a grey-brown appearance and an offensive, often rancid odour and flavour. Rapid development of 'cold storage odour and flavour' was also noted.

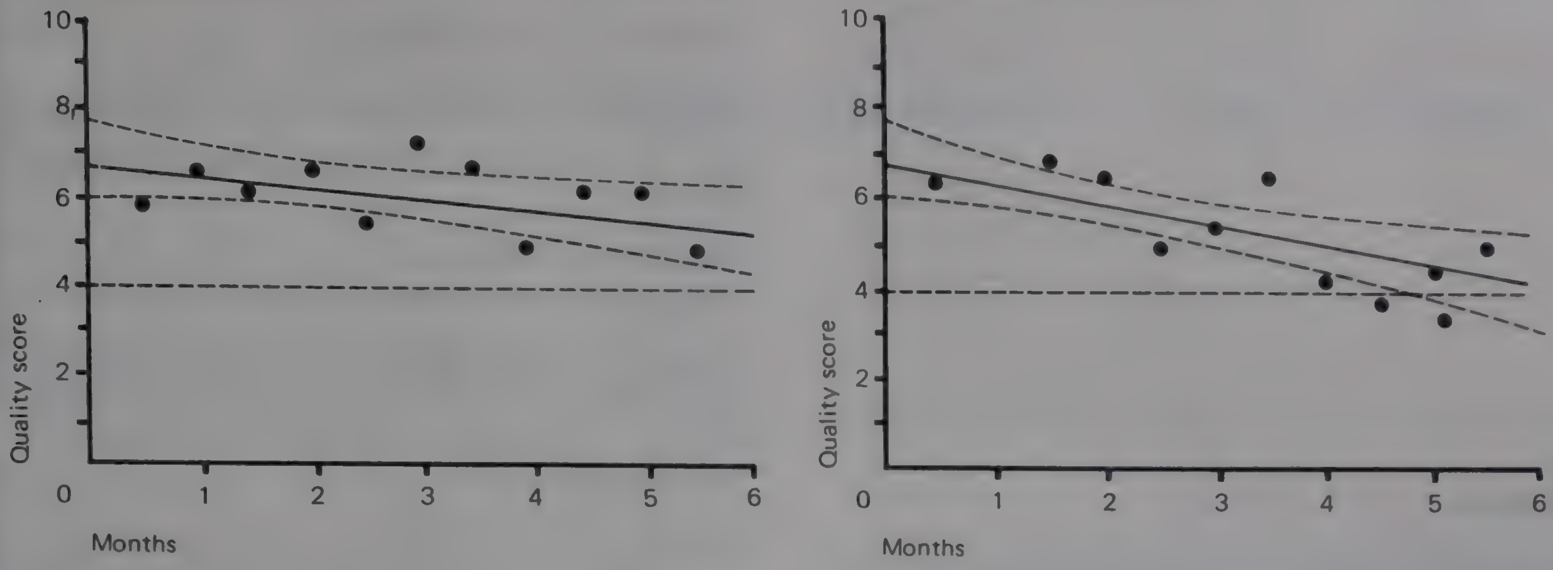
More experimental work is needed in order to specify the optimal conditions for freezing and frozen storage of

TABLE 3. *Chemical composition of fillets from South American hake*

| | | *Chilean hake* | *Argentinean hake (Chiodi, 1966)* | *Peruvian hake (Sanchez, 1974)* |
|---|---|---|---|---|
| Protein | maximum | 17.4 | 18.1 | 16.8 |
| | minimum | 14.2 | 16.1 | 15.5 |
| Fat | maximum | 1.3 | 1.8 | 1.3 |
| | minimum | 0.6 | 0.7 | 0.5 |
| Ash | maximum | 1.3 | 1.3 | 1.2 |
| | minimum | 1.0 | 1.2 | 1.0 |
| Moisture | maximum | 84.5 | 82.0 | 83.2 |
| | minimum | 81.3 | 78.7 | 79.6 |

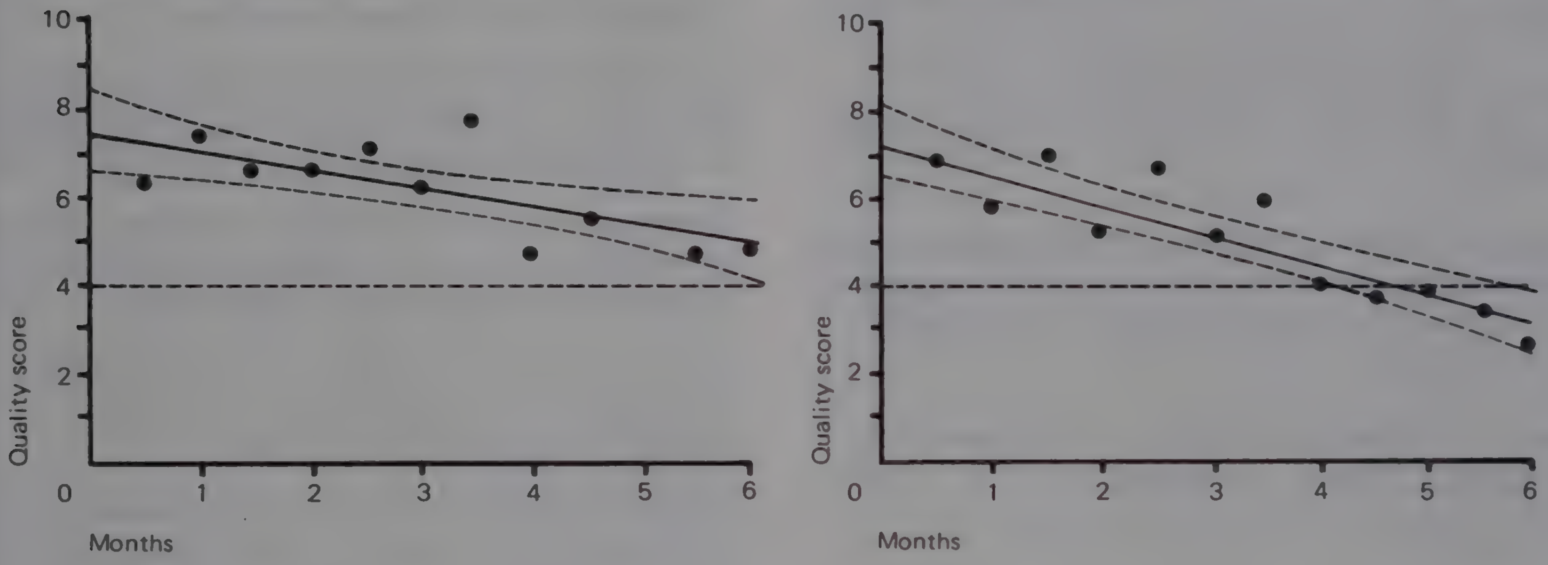
**Figure 3**

**Organoleptic assessment of cooked hake fillets. Regression lines and 95% confidence intervals of means are shown.**



Fillets from fish stored one day in ice, then frozen into blocks and stored at −25°C

Fillets cut from fish stored 7 days in ice, then frozen into blocks and stored at −25°C



Fillets from fish stored one day in ice, then frozen into blocks and stored at −15°C

Fillets cut from fish stored 7 days in ice, then frozen into blocks and stored at −15°C

South American hake. The minimum quality of the raw material must be defined more accurately and the influence of time/temperature variances throughout handling of the raw material, processing and frozen storage must be identified. Although the obvious choice of production appears to be fillet blocks for breaded fish sticks and portions, considerations should be given to other possibilities such as cheap ready-made fish dishes for boil-in-the-bag frozen products. Apart from the practical advantages to the housewife, this type of product offers the possibility of utilizing more expensive packaging, impermeable to oxygen. Spices and sauces can also be added and thus prevent the development of strong cold storage odour and flavour (Jensen, 1975).

## Other hake products

In South America there is very limited production of salted and dried merluza, exclusively for the home market (Jensen, 1975; Andersen, 1974). However, salted and dried merluza can be of excellent organoleptic quality and further studies to promote this product are strongly recommended (Jensen, 1975).

The yield of edible meat in the hake filleting industry could be greatly increased by the use of Japanese type meat-bone separators. The resulting fish pulp is suitable for the production of roll-dried fish protein (Jacobsen, 1975) to be incorporated in pizzas, chupes, empanadas and many other local dishes. As for most other lean fishes, the merluza flesh is not suitable for canning, but merluza roe may be processed in this way (Jensen, 1975).

## Conclusion

The technological characteristics of Latin American hake vary between species and between fishing areas. It applies equally to Argentinean, Chilean and Peruvian hake that they are soft-fleshed fish, requiring great care in the physical handling and rapid chilling at sea in order to preserve their quality. While Peruvian hake should be gutted at sea, this is not necessary for Chilean hake, provided that they are handled carefully and chilled rapidly to 0°C at sea. Whole Chilean hake may be iced in boxes or containerized with chilled sea water, the storage life at 0°C being in both cases about 10 days. Although pink and other discolorations of hake fillets are not uncommon, they may be accepted as 'white fish fillet' for freezing and sale on the world market. There are indications that the shelf life of frozen hake fillets may be rather limited. Brownish discoloration, surface rancidity and 'cold storage odours and flavours' are involved in the deterioration during frozen storage. Further studies are required in order to establish good practices in the industrial processing of frozen hake fillets.

## References

**Aguayo, M.** (1971) *IFOP Bol. Cientifico* No. 16. Santiago, Chile: Instituto de Fomento Pesquero.

**Andersen, P., Appleyard, W. P., de Haan, P. W., Hordijk, G. H., van Noort, E. C. A. and Souness, J. A. R.** (1974) Important aspects of marketing Peruvian Merluza. In: *Fishery products* (ed. R. Kreuzer), pp. 394–396. Surrey, England: Fishing News (Books), 462 pp.

**Burt, J. R., Dreosti, G. M., Jones, N. R., Simmonds, C. K. and Stroud, G. D. (1974a)** Technological investigations into Cape hake. I. Chilling at sea for freezing ashore. *J. Food Technol.* **9**, 223.

**Burt, J. R., Dreosti, G. M., Jones, N. R., Kelman, J. H., McDonald, I., Murray, J. and Simmonds, C. K. (1974b)** Technological investigations into Cape hake. II. Freezing at sea. *J. Food Technol.* **9**, 235.

**Burt, J. R.** (1974) The commercial utilization of Cape hake. In: *Fishery products* (ed. R. Kreuzer) pp. 193–197. Surrey, England: Fishing News (Books), 462 pp.

**Chiodi, O. R.** (1966) Variaciónes estacionales en la composición química de la merluza del atlántico sudoccidental. *Industrialización Carpas 3, Documento tecnico* No. 11. Argentine.

**Dassow, J. A., Patashnik, M. and Koury, B. J.** (1970) Characteristics of Pacific Hake, *Merluccius productus*, that affect its suitability for food. In: Pacific hake, p. 127. *US Fish and Wildlife Service Circular* No. 332. Washington, D.C.

**Dassow, J. A. and Beardsley, A. J.** (1974) The United States experience with Pacific Hake (*Merluccius productus).* In: *Fishery products* (ed. R. Kreuzer) pp. 199–203. Surrey, England: Fishing News (Books), 462 pp.

**FAO** (1974): *Yearbook of fishery statistics,* Volume 37. *Fishery commodities,* 1973. Rome: FAO.

**Grinols, R. B. and Tillman, M.** (1970) Importance of the worldwide hake, *Merluccius,* resource. In: Pacific hake, p. 1. *US Fish and Wildlife Service Circular* No. 332. Washington, D.C.

**Gulland, J. A.** (ed.) (1971) *The fish resources of the ocean.* Surrey, England: Fishings News (Books), 255 pp.

**Halgaard, C.** (1973) A second experiment in the handling of merluza at sea. Working paper prepared for the UNDP/FAO Fishery Project PER 69/535.

**Huss, H. H.** (1971) Quality and keeping time of fresh and frozen Argentinean hake. Working paper prepared for the UNDP/FAO Fishery Project FL:SF/ARG. 102.

**Jacobsen, G.** (1975) Use of separated Chilean hake meat for rollerdried fish protein. Working paper prepared for the UNDP/FAO Fishery Project CHI/72/006.

**Jenson, J.** (1975) The Chilean main fish species and their utilization for consumption. Working paper prepared for the UNDP/FAO CHI/72/006.

**McGill, A. S., Hardy, R., Burt, J. R. and Gunstone, F. D.** (1974) Hept-cis-4-enol and its contribution to the off-flavour in cold stored cod. *J. Sci. Food Agric.*, **25**, 1477.

**Petersen, T. E. and Feldstedt, B.** (1975) Ensayos de neuvos sitemas de manipulación racional para el tratamiento de merluza a bordo. Working paper prepared for the UNDP/FAO Fishery Project CHI/72/006.

**Sanchez, J.** (1974) Technología del salado y secado artificial de la merluza. *Instituto del Mar de Pesca, Peru, Informe No. 43.*

# A new method to classify fishery products by microbial risk

**E. S. Garrett, G. J. Haines Jr, J. R. Brooker, R. W. Hamilton, T. J. Billy, P. K. Stocks**
Department of Commerce, USA
and
**C. A. M. Lima dos Santos**
Ministry of Agriculture, Brazil

## Summary

Seafood consuming nations are ever-increasingly demanding higher quality fishery products from exporting countries. As a result, numerous developing countries with high fishery product exports are initiating fishery product inspection and export quality control systems to safeguard their markets for fishery products. Often, due to competing national priorities and limited budgets, laboratory support activities necessary for inspection and export quality control programmes are inadequately funded. Such necessitates that laboratory support programmes be operated with maximum efficiency and economy.

The paper describes the development and use of a 'Risk Potential Index', a numerical scoring system whereby all fishery products can be screened and categorized by their potential microbial risk. The function of the Index is to classify fishery products into priority groupings so that an effective focus of microbial monitoring can be achieved in any given fishery product inspection scheme. The Index includes sub-routines relative to the type, species and processed form of starting raw material, presence of sensitive ingredients, in-plant processing control procedures, consumer serving methods and differing populations at risk.

## Résumé

Les pays consommant les produits de la mer exigent de plus en plus une qualité accrue des produits de la mer provenant des pays exportateurs. En conséquence, de nombreux pays en voie de développement exportant de grandes quantités de produits de la pêche commencent à réaliser une inspection des produits de la pêche et des systèmes de contrôle de qualité des produits exportés pour sauvegarder leurs marchés de produits de la pêche. Souvent, à cause d'autres priorités nationales et à cause de budgets limités, les laboratoires nécessaires à la réalisation des programmes d'inspection et de contrôle de qualité des produits exportés ne disposent pas des moyens adéquats. Ceci nécessite que les programmes d'aide aux laboratoires soient réalisés avec le maximum d'efficacité et d'économie.

Cet article décrit la mise au point et l'utilisation d'un 'Index de Risque Potentiel', système de notation numérique où tous les produits de la pêche peuvent être triés et classés en fonction de leur risque microbien potentiel. Le rôle de l'Index est de classer les produits de la pêche en groupes de priorité de sorte qu'un contrôle microbien effectif puisse être réalisé dans tout programme d'inspection des produits de la pêche. L'Index comprend des sous-protocoles selon le type, l'espèce, les produits transformés des matières premières, la présence des ingrédients sensitifs, les processus de contrôle dans les usines, les méthodes de protection du consommateur et les différences de risque selon les populations.

## Resumen

Los países consumidores de productos del mar están exigiendo cada vez más de los países exportadores unos productos pesqueros de mejor calidad. Como resultado, numerosos países en vías de desarrollo con elevadas exportaciones de productos pesqueros, están iniciando sistemas de control de calidad e inspección de estos productos para salvaguardar sus mercados. Con frecuencia, debido a competición entre prioridades nacionales y las limitaciones presupuestarias, las actividades de apoyo a los laboratorios necesarios para los programas de inspección y control de calidad en la exportación carecen de fondos suficientes. Ello exige que los programas de sostenimiento de los laboratorios sean dirigidos con un máximo de eficiencia y economía.

El artículo describe el desarrollo y utilización de un 'Indice de Riesgo Potencial', un sistema de tanteo numérico por medio del cual los productos pesqueros pueden ser seleccionados y categorizados a partir de su riesgo potencial microbiano. La función del Indice consiste en clasificar los productos pesqueros en grupos prioritarios, de forma que se pueda obtener un enfoque efectivo del control microbiano en cualquier esquema de inspección de productos pesqueros. El Indice incluye subrutinas relativas al tipo, especie y forma de procesado

de la materia prima de partida, presencia de ingredientes sensibles, procedimientos de control de elaboración en la planta industrial, métodos de servicio al consumidor y diferenciación de las poblaciones frente al riesgo.

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## Introduction

With the ever-increasing sophistication of world-wide seafood production and marketing, there has been a renewed interest in the monitoring of fishery products. Concurrent with this interest has been the formulation in many countries of food control systems specifically designed to address consumer hazards associated with fishery products. Such systems usually have taken the form of national minimal requirements (Codes of Practice) promulgated for quality of raw materials, plant construction standards, hygienic quality procedures, end-product specifications and some sort of inspection procedure on a given frequency necessary to determine compliance with the aforementioned requirements.

One of the shortcomings encountered in the application of the inspection schemes described above is the lack of technical analytical support to monitor products. Obviously one of the reasons for difficulty in obtaining technical support in inspection schemes is the high cost. Another is that the entire area of providing technical support to fishery inspection schemes is so broad as to be seemingly unmanageable to many administrators.

Over the past several years, at numerous meetings and conferences, the authors have discussed approaches and methods to resolve the problem. It was believed that the control procedures monitoring systems published in *An evaluation of the salmonella problem* (National Academy of Sciences, 1969), could be modified specifically for fishery products and serve as a point of departure for initiating a monitoring programme. It was also decided that any monitoring scheme should be based solely upon potential public health risk since that should be the major concern of any fishery inspection programme which has only limited funds to conduct analysis. Additionally, it was agreed that any monitoring scheme should be restricted solely to processed fishery products since raw products, by their nature, must receive some sort of processing and cooking by consumers, which should lessen the chance for illness.

Upon initiating a monitoring system for possible public health hazards, a device must be sought to classify products into priority groupings so that effective focus of resources can be achieved. The classification system to be described later in this report relies on species of the genus *Salmonella* as the indicator organism. This genus was chosen since the stringent heat processing control measures necessary to reduce its incidence, in all likelihood, also reduce most other aerobic pathogens. The Risk Potential Index was devised initially for the detection of microbial contamination since 80% of reported food-borne diseases in the USA are of microbial origin. This is not to negate the possible role of chemical contaminates, relative to public health considerations, in the use of chemically contaminated fishery products. Rather, by basing the system on microbial contamination, it is a realistic recognition that the causative agents responsible for the vast majority of reported food-borne outbreaks in the USA are of microbial etiology.

The categorization system is currently under test, and will be modified as deemed necessary.

## Background

The presence of undesirable micro-organisms, including *Salmonella,* in fishery products can usually be traced to one of three situations: contaminated raw materials, processing malpractices or processing contamination.

### *Contaminated raw materials*

The extreme difficulty, for many fishery product processors, relative to raw material control can be exemplified by the shrimp industry. The final product of this industry is a product which is usually marketed on a size relationship basis ie a specific number of finished products per pound are required from the processing operation. In order for many processors to manufacture a specific 'count-sized' product, many differing lots of raw material must be mixed to meet the required finished product specification. Should any one of the lots be contaminated, such mixing of raw material allows for a multiplying effect of contamination to be introduced into the final product. Each of the beginning lots of raw material may have originated from a different supplier and processed under questionable hygienic practices. When one considers that, in addition to domestic production, the USA is currently importing shrimp from over 80 different countries, the complexity of the problem becomes apparent.

### *Processing malpractices*

For the fish processing industry in the USA, there is a wide variety of fishery products which must be manufactured from raw materials that could be contaminated with salmonellae and other pathogens. With the unknowns associated with the possibly contaminated state of starting raw materials, it is imperative that steps employed in the processing procedures are sufficient to reduce any contamination to acceptable levels.

Again using shrimp as an example, processing actually begins aboard the harvesting vessel and all of the hygienic operating procedures found in the *Code of Practice for Shrimp or Prawns* (FAO, 1975) are designed to reduce or minimize contamination of the catch. When the product reaches a shoreside facility, additional and more stringent control procedures can take place regarding heading, washing, peeling, dipping, final cooking etc. In the case of the cooked product (which will receive little or no additional heat treatment by consumers), it is essential that processing time/temperature procedures employed during heating are sufficient to render the product non-injurious to health.

### *Post-processing contamination*

Related to processing malpractices is the obvious and real possibility of post-processing contamination. Consider for a moment the problems facing a fishmeal manufacturer. In that industry, it can very well be assumed that the basic raw material consists of fish contaminated to some degree with *Salmonella,* either through environmental sources or through the wet-rendering process. Although it took considerable research to determine the time/temperature parameters and equipment modifications necessary to render the heat-treated product *Salmonella*-negative, the solutions were rather simple and practical. The main difficulty was encountered in preventing post-processing contamination. These procedures were worked out, and are now employed by the USA fishmeal industry.

A similar problem is faced by processors of seafood products for human consumption and, again, the various Codes of Practice for fishery products, developed by the Food and Agriculture Organization's Department of Fisheries and the Codex Alimentarius system, address this problem.

With this introduction and background, the authors offer a proposed classification scheme to categorize processed fishery products according to their microbial risk.

## Classification scheme: Risk Potential Index (RPI)

The proposed classification scheme, Risk Potential Index (RPI), is an arbitrary weighted numerical scoring system premised on four major factors:

(1) Species and processing form of starting raw material.
(2) Presence of sensitive ingredients.
(3) Presence of processing control procedures, ie thermal treatment.
(4) Consumer-use (product-serving) methods.

Each of these points is elaborated further.

### *Raw material*

The starting raw material used in the manufacture of any hygienically-acceptable finished fishery product is of considerable importance for the reasons previously stated. Empirical evidence indicates that species of starting raw material can be differentiated into varying risk potential categories due to their environmental ecology, physiological systems and method of harvest. Table 1 lists, partially, in descending order of potential microbial risk, various species and the weighted numerical value assigned to each.

TABLE 1

| *Species* | *Numerical value* |
|---|---|
| Oysters | 7 |
| Blue crabs | 6 |
| Bay scallops | 5 |
| Shrimp | 4 |
| Frogs legs | 3 |
| Lobsters | 2 |
| Fin fish | 1 |

Another consideration which must be given to assigning any priority listing of raw materials deals with its processed form since various forms of processing imply varying degrees in potential risk. Tables 2 and 3 delineate the common forms of processed raw materials and their assigned weighted numerical value.

TABLE 2

| *Processed form* | *Numerical value* |
|---|---|
| Fresh | 10 |
| Cured | 8 |
| Frozen | 6 |
| Cooked | 4 |
| Canned | 2 |

TABLE 3

| *Processed form* | *Numerical value* |
|---|---|
| Recovered material used as starting raw material | 10 |
| Material specifically manufactured for raw material | 0 |

### *Sensitive ingredients*

Differing ingredients in the manufacture of varying food products have historically been well recognized as potential sources of microbial contamination. The acceptance of such fact has led to the development and wide-scale use of sterilized spices in the manufacture of many foodstuffs. Examples of such sensitive ingredients for fishery products are batter mix, dairy mixes, condiments, vegetables and other specialized fish compounds. For the Risk Potential Index, numerical values relative to this factor should be assigned as follows:

TABLE 4

| *Condition* | *Numerical value* |
|---|---|
| *Final product contains:* | |
| Breading, batter and stuffing | 40 |
| Stuffings (eggs and/or seafood components) | 30 |
| Breading and batter | 20 |
| No sensitive ingredients | 10 |

### *Processing control steps*

The third area of concern in the development of this Risk Potential Index centres on whether the product receives some form of processing control to minimize microbial contamination. For this factor, species of the genus *Salmonella* have been selected as the indicator micro-organisms to be destroyed. These micro-organisms were selected since the stringent control measures necessary to reduce their incidence will, in all likelihood, concurrently reduce most other microbial pathogens. Thermal treatment will be considered the rated control procedure for this factor. It is anticipated that relativity of thermal treatment to *Salmonella* destruction will sometimes be unknown. When this occurs, the product should be scored as non-thermally treated. This information will serve as a feedback system to identify needed areas of processing control research. Thus, the numerical treatment should be as follows:

TABLE 5

| *Process controls* | *Numerical value* |
|---|---|
| Non-thermally treated | 30 |
| Thermally treated | 15 |

### *Consumer use (serving methods)*

The final factor to be considered is whether the consumer fully cooks the product prior to serving. The numerical values to be assigned in this factor are:

TABLE 6

| *Condition* | *Numerical value* |
|---|---|
| Not fully cooked by consumer | 40 |
| Fully cooked by consumer | 20 |

### *Population at risk*

In dealing with any scheme for determining priorities for pathogenic microbial analysis of foodstuffs, consideration must be given to the population at risk. Individual segments of the general populations have differing susceptibility for illness from microbial etiology due to their general physiological state and well-being: the elderly and infirm, and infants, are far more susceptible to microbial pathogens than the young and healthy. *Therefore, when any product possesses a known destined utilization for therapeutic, infant, geriatric, or supplement diets, or for infirmed persons, such products must receive number one priority for analysis, regardless of RPI value.*

### *Operational protocol*

Each processor's specifications for plants subscribing to the US Department of Commerce's inspection programme are reviewed by a staff microbiologist of the National Fishery Products Inspection and Safety Laboratory and, with the assistance of the Regional Inspection Supervisor, are scored on the attached form (Table 7) and assigned an RPI value. Upon completion of the specifications review, a pattern distribution analysis is conducted after which an arbitrary priority cut-off score is delineated by the laboratory with the high-scoring products selected for microbiological monitoring. The microbial profiles examined for are coliforms, *Escherichia coli, Salmonella, Shigella,* coagulase-positive *Staphylococcus* and, in some cases, *Vibrio parahaemolyticus.* It is anticipated that after sufficient analyses have been performed, microbiological guidelines for examined pr ducts can be developed.

TABLE 7. *Risk Potential Index evaluation sheet*

US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
National Fishery Products Inspection and Safety Laboratory
Pascagoula, Mississippi 39567

Risk Potential Index (RPI) Evaluation Sheet

Date: ............................................
Product brand name: ..........................................................
Code: .................................. Date of production: ..................
Produced by: ..........................................................................
(Company name)
..........................................................................
(Address)
Population at risk: ..........................................................
Consignee: ..........................................................................
(Name)
..........................................................................
(Address)

*Numerical Evaluation Data*

| *Criteria* | *Values* | *General comments* |
|---|---|---|
| Raw product species | | |
| Raw material processed form | | |
| Sensitive ingredients | | |
| Processing control steps | | |
| Consumer use (serving methods) | | |
| Total values | | |

Additional comments (continue on reverse if necessary):

### *Example of product scoring*

The highest value a product could receive under the aforementioned scoring matrix is 137 and the lowest is 48. An example would be as follows:

TABLE 8. *Product description: Stuffed flounder (processed cooked)*

| *Product characteristics* | *Numerical value* |
|---|---|
| Species: Flounder | 1 |
| Process form: Frozen | 6 |
| Process form: Specific raw material | 0 |
| Sensitive ingredients: Positive | 40 |
| Process controls: Non-thermally treated | 30 |
| Consumer cooking: Fully cooked | 20 |
| Total RPI value | 97 |

### *USDC lot-inspected products*

The Risk Potential Index as described is not applicable to lot-inspected products. The non-applicability of the

Index is due to lack of knowledge of the environmental hygiene of the processed products, raw material acceptability or process controls. Therefore, any consideration for assigning priority values for microbiological analysis of lot-inspected products must necessarily be based on the population at risk.

## Conclusions

Providing technical analytical support to fishery products inspection schemes is expensive and an encumbrance. In the authors' opinion, programmes having only limited funding or analytical resources should probably restrict monitoring to micro-organisms of public health significance. Such restriction is not to negate the role of possible chemical contaminants but rather implies that the majority of food-borne outbreaks of disease will be of microbial etiology.

In determining some priority classification for microbiological monitoring, consideration should be given to the various species of starting raw materials whether the raw materials represent salvage material left over from some previous manufacturing operation, the addition of sensitive materials or ingredients, thermal treatment during processing to reduce incidence of pathogens (*Salmonella,* in particular) and the degree of heat treatment given the final product by the consumer. Any weighting or scoring system for the importance of the different variables can be used at the option of the investigator, and the paper describes the system currently in use by the US Department of Commerce's Fishery Products Inspection Program.

## References

**FAO** (1975) Code of practice for shrimp or prawns. *FAO Fisheries Circular* No. C322, 37pp. Rome: FAO.

**National Academy of Sciences** (1969) *An evaluation of the salmonella problem.* Washington, DC: National Academy of Sciences, 207pp.

# Discussion

During Session 2 there were three discussion periods: one after the paper by **Garm** and **Limpus**, one after **Shewan**'s paper and one after the moderator's review.

## Papers 1 and 2

These papers stimulated active discussion from the floor. The need for quality control in developing countries and some of the problems that may be faced in the implementation of inspection programmes were discussed at length.

The chairman opened the discussion with a question concerning the extent to which fisheries inspection should be applied and he suggested that the smaller companies should be the primary target of an inspection; larger organisations often do not require Government assistance. **Garm** agreed that emphasis should be placed on the smaller processors and he felt that inspection services/programmes can only be operated successfully if carried out with the full co-operation of the industry. If the industry considers the programme to be too rigid or too strict then problems will occur. In this context, the traffic warden analogy was put forward by **Watkins**; industry will try to avoid regulations enforced by the inspectors and it is, therefore, essential to co-operate with the industry. **Watkins** also stressed the need for a strong educational element in the inspection service and was supported by **Golley-Morgan**.

The difficulties of applying the standards of industrialized countries to developing countries were discussed. **Moal** felt that if such standards are applied, then the product may become too expensive for the consumer; the principle of premium prices for high quality fish is not practicable in most developing countries. **Talabi** added that in countries where the fish are mainly caught by artisanal fishermen, it would be very difficult to implement a quality control system. He felt that the concept of quality control in the tropics may still need to be defined. It was generally agreed that for countries with an export industry, inspection and quality control programmes are essential. However, as **Taylor-Thomas** pointed out, The Gambia is a country with a growing export trade, but the legislation, staff and facilities for carrying out quality control procedures are just not available. No ready solution to this problem could be provided; inspection and quality control can only be established over a number of years.

There was a short discussion on the safety of oysters and mussels. **D. T. Jones** stressed that mandatory control is essential; **Moal**, however, felt that any possible health hazard could be avoided by proper cleansing and due care and attention.

## Paper 3

This discussion concentrated on microbial spoilage of iced fish and on other ways of inhibiting bacterial growth.

The discussion opened with a comment from **Peterkin** that no data on fish from the Caribbean had been presented. **Shewan** said that he had been unable to find such information and would be pleased to have any publications on this sent to him. It was generally agreed that there is a lack of information on microbial spoilage of iced tropical fish; a plea was made by **Shewan** for more work in this area.

In response to **N. R. Jones**' question on the relevance of cleaning wooden boards **Shewan** replied that the Torry Research Station findings are conflicting; it is difficult to show that low counts result from cleaning equipment, wooden holds of boats etc. Furthermore, it is almost impossible to thoroughly clean the wooden boards used in fish holds.

There followed a discussion on the mechanism of spoilage. **Golley-Morgan** felt that differences in spoilage of different species may be due to the properties of the slime and the differences in the flora; pH and differences in size are also important. *Pseudomonas* and *Achromobacter* were cited, by **Aagaard**, as being mainly responsible for the spoilage of sardines. **Cann** agreed, but pointed out that, in prawns, either *Pseudomonas* or *Achromobacter* were responsible. The role of bacteria in spoilage was however questioned by **Herborg**: if bacterial activity is mainly in the skin (at least for the first 12 days) and if these bacteria are penetrating the flesh and causing spoilage, he felt that washing should improve shelf life and suggested that metabolism (ie diffusion of enzymes) could be more important.

An opinion on the use of antibiotics was requested by **Herzberg**. In response, **Shewan** pointed out that in Canada, USA and the UK, the benefits were found to be only marginal and antibiotics are not in commercial use.

Conflicting opinions were expressed in response to **C. E. P. Watson's** question on the value of irradiation as a means of inhibiting bacterial growth. **Shewan** thought it was too expensive; **Steinberg** however considered that costs for chilling and irradiation are comparable, but added that there is a danger from *Clostridium botulinum* in stored, irradiated products. **Huss** mentioned that irradiation may allow more fish of poorer quality to be sold and he felt it is better to concentrate on cooling the fish. However, **Liston** put forward the opinion that irradiation does have a role to play. For example, low radiation in conjunction with chilling could be of value for long distance distribution of fish to internal markets, and higher levels of radiation of fish in pouches could be of benefit to developing areas of the world. Extensive trials are currently being conducted in the USA.

**Peterkin** questioned the relevance of investigating bacterial spoilage parameters to the developing countries. The reduced total counts on tropical fish, as compared with temperate- or cold-water species, and their relevance to the setting of international standards of quality (based on bacteriological counts) was pointed out by **N. R. Jones**.

### Papers reviewed by the moderator

The discussion period was very lively and again concentrated on the application of inspection and quality control programmes and the extent to which they should be applied to the domestic and export markets.

After the moderator's review, **Billy** showed a number of slides illustrating the use of the Risk Potential Index. **Bligh** opened the discussion expressing concern over the quality of fresh fish entering the markets. He wondered if, perhaps, it is a myth that 'fresh fish are always better' and that the regulatory agencies are perpetuating a product which is not necessarily preferred by the consumer. Furthermore, **Bligh** was convinced that people generall want good, 'premium', quality fish and that this could be better achieved by the application of sound technolo to produce frozen fish and other forms of processed fis

A discussion on standards for, and inspection of, different products intended for domestic and export markets followed. While it was agreed that rigorous con trol should be applied to exported produce, there was some disagreement as to whether different standards should be set for the two markets. **Lima dos Santos** felt that, ideally, both should be the same, but this was not always practicable. In Brazil, production is largely domestic and in some areas, all the dried/salted fish on sals if of poor quality, often containing sand. The consumer has no choice, but to buy poor quality fish. This point was taken up by **Garm**; if fish are scarce, it is preferable to eat fish of poor quality rather than starve. It i a question of balance; standards required will depend on the country and its situation or needs. Quality control costs money and the application of quality control measures may raise the cost of the product beyond reach of the ordinary consumer. **Garm's** final point was that he would expect there to be Government regulations to enforce the removal of sand, at least, from the dried/ salted fish mentioned.

**Disney** suggested that a case could be made, in terms of practicability, for lowering the standards for products destined for the domestic market. **Iyer** disagreed and questioned why standards applied to factories making products for the export market should not apply to other factories producing for the internal market. **Iyer** expressed the opinion that inspection should, initially, be voluntary; there should be a trial period to establish whether the standard can be met before the programme is implemented. Finally, it was suggested by **Guadarrama** that developing countries should try to find the best method and the best system for each type of fish product.

There was a question from **Bonsu** asking if **Herzberg** had carried out peroxide tests since oxidation is the problem with sardinella. He replied that they did, but the fat content did not affect spoilage.

# Session 3

## Fresh fish

**Tuesday 6th July**
**Morning**

Chairman
V. O. Sagua
Kainji Lake Research Institute
Nigeria

Moderator
J. M. Shewan
Torry Research Station
UK

Rapporteur
H. H. Huss
Ministry of Fisheries
Denmark

# Fresh fish: the problems in small-scale fisheries

**H. Lisac***
Department of Fisheries, FAO, Rome

**Summary**

Problems in handling and transporting fresh fish under difficult conditions and at high ambient temperatures in developing tropical countries are discussed. The absence of adequate facilities on fishing boats and ashore prevents the distribution of good quality fish and results in traditional processing at landing places, which represents a net loss to the fishermen. Efforts to overcome these severe problems are described and a number of possible solutions to problems in small-scale fisheries are suggested.

**Résumé**

Ici sont traités les problèmes de manipulation et de transport du poisson frais dans des conditions difficiles et à des températures ambiantes élevées dans les pays tropicaux en voie de développement. L'absence d'équipements convenables sur les bateaux de pêche et à quai empêche la mise en vente de poisson de bonne qualité et a pour conséquence l'utilisation de procédés traditionnels aux lieux de débarquement, ce qui représente une perte nette pour les pêcheurs. Les efforts pour venir à bout de ces problèmes difficiles sont décrits et un certain nombre de solutions possibles à ces problèmes dans les petites entreprises de pêche sont suggérées.

**Resumen**

Se examinan los problemas en la manipulación y transporte de pescado fresco bajo condiciones adversas y a altas temperaturas ambientales en los países tropicales en vías de desarrollo. La ausencia de medios adecuados en los barcos pesqueros y en tierra impide la distribución de pescado de buena calidad y obliga a realizar el procesado tradicional en las zonas de desembarco, lo que representa una pérdida neta para los pescadores. Se describen los esfuerzos para superar estos graves problemas y se sugieren una serie de posibles soluciones a los problemas de las industrias pesqueras a pequeña escala.

## The problem

Small-scale fishermen in developing countries are faced with enormous difficulties in marketing fresh fish. The lack of suitable infrastructure, including rapid transport, refrigeration etc, increases the problems caused by rapid spoilage at high temperature. However, some improvements are possible without over-sophistication.

Fishing vessels in small-scale fisheries are, as a rule, small craft; the dug-out, paddle-propelled canoe still being very often used. The fishing gear which can be used in such small vessels often determines the fishing method, some of which, such as gill nets, can adversely affect the quality of fish even before they are taken out of the water. Limited space in these vessels does not favour proper handling and preservation of the catch on board. Even if ice and fish boxes or insulated containers are available on shore, there is no space on board to take them to the fishing grounds. Such small vessels are slow and it either takes a considerable time for them to reach a major landing place or they have to unload their catch at small, scattered landing places.

In many small-scale fisheries operating with very small vessels, daily landings per fisherman are estimated at between 4 and 20 kg. In others where, in addition to the small craft a certain number of medium-sized vessels are used, daily estimated landings vary from 40 to 100 kg per fisherman. These are, however, only estimates based on the total annual catch and the number of fishermen involved in a fishery (Table 1).

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* Paper presented by D. G. James, Department of Fisheries, FAO, Rome.

TABLE 1. *Average annual catch per fisherman in some selected small-scale fisheries*

| *Fishery* | *Year* | *Annual catch (tonnes)* | *Number of fishermen* | *Annual catch per fisherman (tonnes)* | *Source* |
|---|---|---|---|---|---|
| Mauritius | 1973 | 2,000 | 3,500 | 0.57 | Munbodh, 1975 |
| Indonesia | 1971 | 1,266,000 | 810,000 | 1.56 | Magnusson, 1973 |
| Lake Nasser | 1971 | 6,700 | 3,600 | 1.86 | Abdel-Latif, 1974 |
| Lake Chad | 1973 | 50,000 | 20,000 | 2.50 | (estimate) |
| Lake Volta | 1968 | 25,000 | 9,000 | 2.78 | Taylor & McAlister, 1969 |
| Uganda | 1972 | 160,000 | 31,000 | 5.16 | Dhatemwa, 1975 |
| Tanzania | 1973 | 160,000 | 16,000 | 10.00 | Maembe & Magoha, 1975 |
| The Gambia | Av. 72/74 | 18,500 | 1,500 | 12.33 | Kristjonsson & Talarczak, 1975 |

In small landing places with low, daily catches it is often uneconomic to provide the facilities and supplies which would enable proper care to be taken to preserve fresh fish either on board or immediately upon landing. If the landing places do not have suitable roads to the major sources of supply (eg, ice or chill storage depots) very little can be done to prevent or reduce spoilage. Even where good roads to distant markets exist, fast transportation may not be economical, due either to the shortage of road vehicles or to the small quantities of fish involved.

As a consequence, only a fraction of the fish landed at small landing places is distributed as fresh fish, often by porters or by bicycle, to small villages up to 20 km distant. The major portion of the catch is processed by traditional methods of salting, drying or smoking at the landing place. The remainder is completely wasted. Fish processed by traditional methods normally gives a lower return to fishermen than it would had it been sold for fresh consumption. This represents a relative economic loss to fishermen and is, very often, a reason for reduced efforts in fishing activities and, consequently, for reduced supply of fish to consumers in areas where there is a shortage of protein.

These problems are apparent in some inshore marine small-scale fisheries but they are very much more pronounced in inland fisheries, particularly on natural or man-made lakes and swamps and, to a somewhat lesser extent, in river fisheries. Efforts are being made to overcome some of the problems connected with fresh fish distribution in small-scale fisheries. These efforts are necessary to ensure relatively cheap and much-needed good quality protein for low-income groups and at the same time ensure at least a subsistence level of income to the fishermen.

A few examples of the present situation and efforts to improve it are described in this paper. In addition, some possibilities for reducing or alleviating the problems are briefly outlined. These might serve to stimulate a discussion on the greater involvement of government authorities, applied research institutes and the fishing industry in the gradual improvement of the status and quality of fresh fish supplied by small-scale fishermen.

## Alternative approaches to improve the situation

The price paid by consumers for fresh fish is strongly influenced by the structure and organization of the collection and distribution system. The fisherman often receives only a small fraction of the retail price. The factors responsible for this vary, but they are largely the result of excessive costs accruing in the distribution process. It is often insufficiently appreciated that investments in equipment and facilities required for proper handling, storage and distribution of fresh fish will lead to reduced marketing costs per unit of throughput, provided appropriate use is made of the equipment and facilities (FAO, 1971a). However, in small-scale fisheries, a thorough feasibility study should precede any investment to find out if it would be economically justified.

### *Icing*

It is generally recognised that there is no better and more suitable way of preserving fresh fish than icing and keeping it chilled with ice. This also applies to small-scale fisheries whenever it is technically or economically possible. Unfortunately this is not always the case.

Flake ice (or other types of small ice) machines are often recommended for use in small-scale fisheries, particularly if installed at landing sites on top of insulated, and possibly refrigerated, ice stores. Two small ice machines are preferred to one larger machine of equal capacity, in order to provide more flexibility in the event of one of the machines breaking down or needing servicing (Roach, 1974). It should, however, be borne in mind that the small and irregular landings often make ice production uneconomical.

Large amounts of fish in Indonesia are spoilt by inadequate use of ice; there is an urgent need for practical demonstrations to fishermen on how icing of fish can best be carried out to their own benefit (Magnusson, 1973).

Several West African marine fish remain acceptable for 20 days if iced, whereas they spoil completely in 24 hours at ambient temperature (Aldrin *et al.*, 1970). Earlier work by the Tropical Products Institute has shown that the early application of ice extends the storage life of several African freshwater species to approximately four weeks. Indian carp in ice were acceptable for up to five weeks, and some marine tropical fish have a longer storage life in ice than temperate-water species. Investigations on four West African species indicate a storage life, in ice, of more than three weeks (Amu and Disney, 1973). It has also been reported that one hour's storage of East African *Tilapia* sp. at ambient temperature (24° to 30°C) is roughly equivalent to one day's storage in ice (Disney *et al.*, 1969).

A report is available which suggests that only 1 kg of ice, mixed with 3 kg of Volta Lake fish, would permit transport of good quality fresh fish to the processing site and ensure higher prices being paid to fishermen (Taylor and McAlister, 1969).

The price of ice varies from place to place. It is, for example, available to fishermen in Ujung Pandang, Indonesia, at Rp 14* per kg while the retail price of fresh fish fluctuated between Rp 300 and Rp 400 per kg in 1975 (Schroedter, personal communication).

Work by the Central Fisheries Technological Research Institute in India on two species of freshwater fish has shown that if they are kept at ambient temperatures for six to eight hours prior to icing, they remain acceptable for four weeks. Similarly, according to Disney *et al.* (1974) in Uganda, *Tilapia*, kept for six hours prior to icing, had practically the same storage life as if they had been iced immediately after capture. It may not therefore be necessary to ice on board in all fisheries (Disney *et al.*, 1974). It was also found with *Tilapia* that gutting improved quality during ice storage but it would be very difficult to apply it in small-scale fisheries (Watanabe, 1965–66).

### *Alternative preservation methods on board*

The limited use of ice may be due to its high cost or to the lack of knowledge of the beneficial effect of ice on the storage life of fish. The solitary fisherman in his dugout canoe cannot make any great outlay for ice or mechanical refrigeration and his means of keeping fish must be simple and inexpensive. If the fish are small, uninjured and can stand being enclosed, the live well is the best means of keeping the fish fresh. Another method is to place the fish in a shallow layer on a coarse screen in a shaded place, exposed to the breeze. If a few pieces of wet burlap are placed over them, the rapid evaporation of the water from the burlap will lower the temperature of the fish below that of the air and will help preservation. However, the burlap should always be kept wet.

No ice is used for preserving fish on board small sailing boats in Indonesia, but sometimes the fish stay alive in the keel water until brought ashore (Magnusson, 1973).

A good fish box for small-scale fishermen in the tropics should combine the elements of insulation, sturdiness and low cost. It should be easy to handle, should nest with other boxes for return shipment, should have adequate drainage and should soak up as little water as possible. Whenever feasible, small portable insulated containers should be used on small fishing craft to transport fresh fish in ice to the landing site and sometimes through to the retailer.

In some places it is up to the fish trader to bring ice in insulated containers to the landing site. Of course, he must make a decision whether he can bear the cost of icing in relation to the retail fish price.

In some countries fresh fish from small-scale fisheries do not present any particular problem. For example, in Mauritius, fish are landed at 42 stations around the island and 15 of them have adequate facilities to handle the limited catch. Most landing stations are accessible by motor vehicle via a system of good roads; no market is situated further than about one hour's journey from the landing site. Fresh fish storage facilities are not required at the landing or in the marketing places. Due to the fact that there is usually only one fish dealer involved and fairly low transport costs, the market price is only slightly higher than the price paid to the fisherman (Munbodh, 1975).

### *Collection of fresh fish*

It is very difficult, often uneconomic and sometimes impossible to utilize efficiently fresh fish landed by small-scale fishermen at many scattered landing places. As a result, attempts are made to collect fresh fish directly from fishermen, at the fishing grounds or in fishing villages, by fish carriers and unload it at central landing places where adequate facilities for the operation exist. As will be seen from a few selected examples, such an operation can be successful only under certain conditions. The fresh fish carriers must carry ice on board and have insulated or refrigerated holds. Adequate piers or jetties for fast unloading and a ready supply of ice, fish boxes and fuel, as well as chill storage and transport to the interior, should be available at the central landing places. It is, however, of utmost importance that such fish collection schemes are technically and economically well planned in advance, and that they are efficiently operated and managed.

An example of a fish collecting system for small-scale fisheries is the *Tilapia* fishery at Kisumu in Kenya. An 18 m steel vessel, with an insulated and refrigerated hold, collects overnight catches from a fleet of gill-net canoes. The fish are chilled, stored in the hold and landed at two-day intervals. The landed fish are washed with chilled water, packed in wooden boxes in ice and shipped that night by train to markets in Nairobi about 300 km away (Roach, 1974).

A fresh fish collecting scheme was also organized at Mopti, Mali. Traditional wooden launches, provided with outboard motors and carrying locally-made insulated containers with ice, collect fresh fish from fishermen fishing between 10 and 50 km from Mopti. The fish collected are iced on the launches and transported in containers to Mopti, where they remain for up to three days before being transported, in ice, by insulated lorry to the fresh fish market at Bamako, 600 km away. Previously, this fish was dried on the beach, often with a loss of over 20 per cent of dried fish weight due to insect infestation.

Since the dried fish collection scheme carried out at Volta Lake was unsatisfactory, a demonstration fresh fish collection scheme was introduced. Kpandu Tokor, a central landing place with a 2 ton per day ice machine, a transport launch with insulated containers, and efficient smoking ovens, was chosen as the centre. The launch visited the fishing villages daily and properly smoked fish, produced in Kpandu Tokor from fresh raw material, fetched higher prices than before (Taylor and McAlister, 1969).

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* Indonesian Rupiah (Rp) 415 = US $ 1.00, as per February 1975.

In 1970, some of the fish from the 300 km long Lake Nasser, Egypt, were salted in fishermen's settlements and some were transported fresh, by fish carriers, to the fish harbour at the High Dam, for further distribution by land to the markets in Aswan or Cairo. An old house-boat, 35 m in length, was used as an unloading station, where two carriers could be unloaded simultaneously at a speed of up to 1.5 tonnes per hour each (Abdel-Latif, 1974).

The unloading however, was too slow and expensive, there was a general lack of cleanliness and proper handling of the fish, and there was not enough space available for unloading fish. This resulted in a higher rate of spoilage than necessary. It was suggested that, with better organization and modest expense, the unloading and handling of fish could be improved along the following lines:

(a) All fish should be immediately iced and kept in boxes in the holds of carrier boats.

(b) At the harbour these boxes would then be transferred rapidly under the roof, close to the weighing scale.

(c) For unloading the boats, several narrow floating piers holding portable conveyers would be built.

(d) The transporting trucks would be loaded directly after weighing (Magnusson, 1971).

Later the Southern Fishing Company (SFC) took over responsibility for collecting the catch. In 1973, the fleet of 54 SFC carrier boats (Table 2) used crushed ice to preserve the fish which were stored in insulated fish holds. Four floating refrigeration stations were completed to rationalize the fish collection. Each station was equipped with two chill stores, with an estimated capacity of 60 tonnes of boxed iced fish, and was intended to serve about 600 fishing boats as transhipment and supply centre. Some supplies were carried and there was radio communication with the High Dam harbour. By using these stations, it was planned to reduce transportation costs on the lake from LE38.4* to LE32.3 per tonne. The Fishermen's Co-operative Society (FSC) has shown reluctance to use these stations on the grounds that too much handling of fish will result in spoilage and a larger loss in weight. Therefore, in June 1973, a trial was run at one of the stations. The immediate results showed that the storage capacity was only about half of that expected, the storage expenses were much higher than estimated because the ice consumption for transportation was three times higher than without the stations, transportation costs for one tonne were higher than LE38.4, and several other factors were expected to create further problems. Consequently use of the floating stations was not recommended and the trial was suspended after one month (Feidi, 1975).

Ujung Pandang, the main fish market in South Sulawesi, Indonesia, has inadequate landing facilities; the fish are commonly transported in baskets by porters who wade through the muddy water to the shore in front of the market. The market itself is very well constructed and has a capacity of up to 150 tonnes of fish per day (Schroedter, personal communication). A suitably constructed jetty would in this case considerably improve the speed of unloading and therefore significantly reduce the spoilage of the fish landed.

TABLE 2. *Number and specifications of carrier boats used by the Southern Fishing Company on Lake Nasser in 1973*

| *Horse power* | *Capacity of hold (tonnes)* | *Number of boats* | *Total capacity (tonnes)* |
|---|---|---|---|
| 20 | 2.5 | 6 | 15 |
| 25 | 3.8 | 19 | 72.2 |
| 49 | 2.5 | 5 | 12.5 |
| 50 | 7.0 | 9 | 63.0 |
| 54 | 4.5 | 5 | 22.5 |
| 84 | 6.0 | 2 | 12.0 |
| 110 | 13.0 | 4 | 52.0 |
| 200 | 50.0 | 2 | 100.0 |
| 240 | 65.0 | 2 | 130.0 |
| *Total* | | 54 | 479.2 |

The marketing of fish in ice could be greatly increased by organizing fish transport services and using carrier boats to bring iced fish from the small sailing boat fishermen, who operate along the coast of Java, Indonesia, to the main landing centres that have good road connexions (Magnusson, 1973).

In some cases, the local conditions (operating at small landing places) lend themselves to fish collection, from small-scale fisheries, and transport over good roads to a centre where shore facilities exist for storage of fresh fish and its subsequent processing into products for export markets. For instance, in The Gambia, 300 canoes land about 20,000 tonnes of marine fish per year in eleven small landing places along the coast. Some of these landing places are connected by good roads with the capital, Banjul, where freezing facilities, cold stores and an export harbour exist; the fresh fish could be transported from the landing places to Banjul in less than two hours. At present the fish is traditionally smoke dried at the landings; if these landing places were improved and supplied with chill rooms and transport facilities, the catch from the canoes could be frozen in Banjul for export thereby providing a better return to the fishery. The fish resources and natural conditions seem ideal for tripling the fish production of the small-scale fisheries sector as it is likely that export markets for frozen fish can be readily identified.

### *Change from small-scale to medium-scale*

Due to the primitive handling methods used in the canoe fishery of Lake Victoria in 1969, part of the catch was often spoiled by the time it reached consumers. Fish are caught in gill nets and are transported without ice, during which time fish temperatures as high as 35°C may be reached. The introduction of ice into this fishery would make it possible to market fish of a better quality over a wider area than is possible without ice, but the high investment costs and technical difficulties make this impractical. It was, however, proved that chilled fish were very acceptable to consumers in preference to dried and smoked products wherever offered for sale (Roach, 1974).

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* Egyptian Pound (LE) 0.40 = US $ 1.00, as per February 1975

The development of an entirely new fishery, changing from small-scale to medium-scale might make it economically feasible to take better care of the catch. Such a change would require trawlers or seiners, new port receiving facilities and an entirely new approach to fish handling on Lake Victoria. It would also be essential that the shore developments parallel the introduction of new fishing methods. Careful consideration must be given to the design of suitable vessels, landing sites, ice plants, chill rooms and processing facilities, as well as an effective fresh fish distribution network (Roach, 1974).

### *Landing centres*

Suitable landing facilities for a small-scale fishery should include a fixed jetty adjacent to the fish receiving centre. A fixed jetty is strong and durable and requires little maintenance, but is relatively expensive. An alternative to the fixed jetty is the floating wharf which may be of simple construction, is not affected by changes of water level, does not need elevating equipment and can be relatively inexpensive. Services provided on landings should include an electric power supply for elevating equipment, fresh water, a smooth level surface so that wheeled trucks can be used to transport the fish to the handling plants, and, if possible, a slipway to facilitate hull repairs and painting of vessels (Roach, 1974).

Fish handling facilities at each landing site must be designed to deal with the landings rapidly and efficiently. To avoid losses from spoilage under all conditions, facilities are required for the following operations: gutting and filleting, salting, smoking and drying, and freezing (chill and frozen storage facilities are also required). Small landing sites may not need to carry out all of these operations. The following are the minimum facilities required for an efficient and sanitary fish handling station.

(a) The building should have smooth, reinforced concrete floors, concrete block walls finished with a smooth plaster coating, and a trussed roof covered with corrugated aluminium sheeting. Smooth concrete floors should slope to sumps and drains and this concrete surface should continue 30 to 45 cm up the walls. The buildings should be well screened.

(b) Clean fresh water under pressure should be available. A supply of hot water should be provided for washing utensils and working surfaces within the plant.

(c) There should be an ample supply of small ice or crushed ice to supply the needs of both the boats and the plant. If ice, at a reasonable price, is not available close to the landing site, an ice plant with ice storage should be installed at the site. Large fish boxes, preferably made from smooth plastic or metal, should be supplied for transporting fish from the boats and for storage of fish in the plant; similar smaller boxes for storing fillets should also be supplied.

(d) Benches are required for cleaning, filleting and packaging. These should be of smooth concrete or stainless metal for ease of cleaning. They should be provided with freshwater hoses and troughs for drainage and collection of offal. Wooden surfaces in the processing area should be kept to an absolute minimum. A 'walk-in' chill room for short-term storage of pre-cooled iced fish should adjoin the ice storage room. For sanitary reasons the two should be separate and have separate doors. The dimensions of these rooms will depend on the maximum quantities of fish to be stored and on the ice requirements of the vessels. Prefabricated insulated chill rooms refrigerated by independent unit coolers seem to be a very suitable solution under developing conditions. Facilities for bulk drying and smoking may be needed.

(e) An efficient system should be installed for screening and collecting the waste from washing, gutting and filleting operations. The solid material should be sent to a reduction or silage plant, or should be removed and disposed of daily in some other way. Disposal of the waste liquids will also present serious problems. These must be disposed of in a sanitary manner so as not to contaminate the plant area (Roach, 1974).

(f) A platform scale for weighing fish and a suitable hand operated trolley for transportation within the plant are required. An ample parking and manoeuvring area for trucks is essential for rapid distribution of fresh fish to markets.

Comprehensive information, on factors to be taken into consideration when planning the purchase of a small-size ice plant, and specifications, to be provided to ice plant manufacturers at the time of ordering the plant, are available (Lisac, 1974).

### *Distribution*

Although in very many places fresh fish is preferred by consumers and brings better returns to fishermen, the catch is often processed because road connexions, transport facilities and management of fresh fish transport are inadequate.

Transportation of fresh fish in ice should be by trucks used specifically for that purpose. Since this transport in Java, Indonesia, is badly organized, the cost of transporting iced fish is many times higher than that of any other fish commodity. This and inefficient retailing are the main reasons for the low sale of fresh fish at the inland markets (Magnusson, 1973).

Fish (mainly ndagala) in Burundi are very seldom marketed in a fresh form and ice is an unknown concept in fresh fish sales. Supplies to the interior are irregular and quantities small. It should be emphasized that the demand for fresh fish is strong and there are definite possibilities for increasing total fish sales by 'phasing in' fresh fish marketing. Marketing of 'industrially' dried ndagala is the main aim of the Société Régionale pour la Développement de la Pêche. It is suggested that the Société's expansion into 'fresh fish' should be postponed until a later stage since it is recognized that, were the Société to engage in fresh fish handling and distribution on a large scale, this would require a major reorganization of the Bujumbura Central Market. It would further necessitate the introduction and promotion of the presently unknown concept of ice in fish distribution. This may well prove burdensome on the Société in its infant stages (Vidaeus, 1975).

No ice is used on canoes in Uganda and, although large quantities of fresh fish are transported to the main markets in Kampala (400 km away), ice is used only very occasionally. Transport is by lorries, pick-ups, taxis or bicycles. As there are many scattered landing places, the Government is able to provide only a few of them with a water supply, fish boxes, fish stores and ice plants, and is planning to do the same for more major landing places (Dhatemwa, 1975).

Many fish landing places in Tanzania are scattered, with difficult access by road, and lack proper fish handling facilities. The Government plans to establish fish receiving facilities at selected landing centres and to give assistance to receiving stations in order to increase the supply of fresh fish, of improved quality, to the main consuming centres. This assistance includes the availability of extension personnel to instruct fishermen on good handling practice; financial support to improve handling facilities; expert advice on fish handling from The Fish Processing Research Institute, Nyegezi, Mwanza; as well as the formation of National Cold Chain Operations (NCCO) and the Tanzania Fisheries Corporation (TAFICO). This will ensure higher returns to fishermen through organized, well-planned and efficient marketing and transportation systems. The NCCO and TAFICO are opening fresh fish stores in the country. The NCCO is involved in transporting perishable fishery products by insulated and/or refrigerated trucks; the railways occasionally transport fresh fish in insulated and refrigerated cars (Maembe and Magoha, 1975).

Some twenty years ago in India, in the states of Bombay and Madras, rapid transport facilities were provided by introducing motor launches and buses. The fishing societies of these states introduced, in addition, more than 60 trucks to carry the catch from landing places to the centres (Siddiqi, 1956).

## Some specific considerations in fresh fish utilization

The ultimate goal in resolving the problems associated with fresh fish in small-scale fisheries is to find out how, under the existing climatic, development and social conditions in a given area, to utilize the catch to the best advantage of fishermen and consumers. At the first glance, supplying consumer markets with fresh fish from these fisheries seems to be the best and most straightforward solution. However, there are cases where it is economically not feasible. A few examples of alternative possibilities of utilization (including the trade in live fish) and processing at landing places are outlined below in order to stimulate further discussion on various aspects of utilization of fresh fish.

### *Live fish*

In Israel, efforts were made to sell live fish many years ago. The fish were carried in trucks equipped with canvas tanks filled with water. A five ton truck could transport a ton of fish. The retailers kept the fish alive in small tanks and the consumer received it fresh (Siddiqi, 1956).

In the lagoons and backwaters of Nigeria catfish, caught mainly with traps, are kept alive in small 'livepens' or baskets immersed in water and sold to fish collectors. These catfish need only a low amount of oxygen and will remain alive at the fish markets with a very small quantity of water. The amount of live fish distributed is relatively small, but fair prices are obtained by fishermen (FAO, 1969). It should be mentioned that a strong consumer preference for live catfish exists in these areas.

The amount of fish sold live for retail distribution in Java, Indonesia, varies from year to year and detailed records are not kept. However, the officers at the Inland Fisheries Head Office in Bandung have calculated that in 1971 between 20,000 and 30,000 tonnes were sold in West Java. Besides local consumption in the producing areas, the main markets are in Jakarta and Bandung. The principal problem is the lack of adequate transportation from the producing areas to the consumer centres. The amount producers can sell as live fish and the prices they can obtain fluctuate from time to time, mostly because of the lack of a good sales organization. The present complicated marketing system is often responsible for the fish being spoiled and the low prices paid to the producers.

The first step in marketing live fish is for numerous sub-collectors to receive the fish from the producers and transport them to collecting stations. Here they sell to the main collectors, who normally have fish ponds or tanks where the live fish are kept until they are sold again for transportation to Jakarta or Bandung. Some fish are also sold at the local markets; the sub-collectors or the producers deliver the fish to the retailers in each town. The distribution of live fish in West Java is traditionally done in locally-made watertight straw baskets especially designed for the purpose. The bulk of the fish sold in Jakarta and Bandung is transported in these baskets by any available means of transport. When the fish arrives at Jakarta or Bandung, retailers sell them directly from the straw baskets or empty them into tanks built for keeping live fish. In some cases, some of the fish are dead when they reach the retailers. Whole baskets of fish might therefore be spoiled and, although retailers often try to produce salted and dried fish from these fish, the product is never good (Magnusson, 1973).

It is believed that with better organization and more suitable facilities for handling live fish in Jakarta and Bandung, spoilage and waste could be reduced, and the overall handling and marketing expenses substantially reduced. To achieve this, the following suggestions have been made:

The general arrangement of the suggested live fish collecting and marketing station is that part is reserved for buying and selling live fish to be shipped to other markets, another part is for retail sale to local people, and a third part, with live fish storage tanks, is for renting to those who cannot sell their fish at acceptable prices immediately. Using such a station, the live fish collectors or fish farmers would bring the fish in watertight boxes or baskets to the station by their own transport or by trucks owned by the station. The collecting and marketing station could best be operated by fish farmers' co-operatives with technical assistance from the Directorate General of Fisheries. In this way the present complicated marketing chain would be bypassed, costs kept lower and, by producing a relatively steady flow of live fish to the retail outlets, consumption would increase. Marketing fish live is an inexpensive method of bringing fish to consumers in Java, but the transportation costs form 70 to 80 per cent of the total marketing cost. It is suggested therefore that each station operates its own truck equipped for distributing live fish; this should reduce the transportation part of the marketing costs (Magnusson, 1973).

### *Processing at landing places*

The improvement in storage life and quality which may result from processes such as the use of ice, gutting, bleeding, hygienic handling etc, must be balanced against the economic return in such changes and the question of consumer acceptance must also be considered (Disney *et al.*, 1974). A distinction should however be made between the handling requirements of fish intended for domestic use and for export markets.

Boiling of fish is a method of short-term preservation under tropical conditions and is widely used in the Indo-Pacific region. The process consists of brining the fish in saturated brine for a short time and then boiling for a few minutes in saturated brine. The keeping quality, depending on the process, is stated to be two to ten days at ambient temperature. The product is used in the same way as fresh fish (Subba Rao, 1967).

Hot smoking and grilling in Africa and boiling in brine in the Far East are the methods of cooking used to provide cheap, short-term preservation of fish in many parts of the tropics. The products are pasteurized rather than bacteriologically sterile.

Due to the difficulty of delivering fresh fish directly to the markets, fish in small-scale fisheries are generally sun dried, smoked or salted by individual fishermen or their families. These processes and the unsuitable storage conditions for the products often result in quality, quantity and value losses to fishermen. Some improvements could be achieved if the fish were brought to the landing places immediately after catching. Even if good communications with markets are absent, appropriate facilities for traditional processing and storage would ensure the production of traditional products of more uniform quality; with better storage and bulk transport to market at less cost, the fishermen would be in a better bargaining position with the fish traders.

Central landing places with good communications to fresh fish markets can be equipped for bulk processing of fish and storage of processed products, either to satisfy the demand of markets for a variety of products or to be able to cope with the supply of fish on days of particularly abundant landings. The processing facilities should possibly be constructed to be efficient at the lowest possible capital costs.

Trials, comparing the profitability of fresh fish with traditionally processed *Tilapia* and barbel, were carried out in the Kafue River flood plain in Zambia. These fish could not be sold as fresh due to the distance from markets and the lack of ice.. The established market price for fresh fish was K 0.16/kg*, for processed *Tilapia* was K 0.40/kg and for processed barbel was K 0.30/kg. Different smoking, salting and drying methods and the final yields after one month of storage were examined. The processing costs were calculated only on the basis of yield obtained from fresh fish (K 0.16/kg) while other additional costs were not accounted for. These processing costs have shown that whatever method was tried there was a clear loss of value after processing. The losses were different but the highest were for dried non-salted *Tilapia* (yield 31.3, lose 21.8%) and for smoke dried gutted barbel (yield 28.5%, lose 46.6%). The above trials were intended as background material for decisions on how much expenditure could profitably be invested in fresh fish distribution or, which processing method should be used to avoid total loss of fish due to spoilage (Yamamoto, 1975).

### *Fresh fish markets*

Consumer surveys conducted in Java, Indonesia, show that the consumption of fresh fish preserved in ice would greatly increase if it were more readily available as a good quality food. Also, a better marketing organization would increase the income of the fishermen who are now salting and drying the fish and receiving approximately the same price as if they had sold it fresh. For example in 1972, consumer prices of sardines and anchovies were Rp 50 and 40/kg respectively, regardless of whether fresh, smoked or salted; small tuna was sold at Rp 350/kg if fresh and at Rp 400/kg if either smoked or salted (Magnusson, 1973).

A central wholesale market has been planned for Kampala Uganda and will include an ice plant, refrigerated storage and the services of insulated trucks as well as bicycles with insulated containers for short distance transport of iced fish. It is hoped that this will help to stabilize the fresh fish market prices (Dhatemwa, 1975).

Landing places for small sailing boats in the Java Sea, Indonesia, are numerous. Some have road connexions to inland markets and, with improvement, all could give good service to the small sailing boat fisherman. Additional market places are, however, needed in many areas. Where there are good road connexions the fish can be transported to inland markets, but where roads are absent, the fish could be transported by motorized carrier boats to the larger central fish landing and marketing centres. Such fish marketing places usually have no wharf and the boats land on the beach or in the river mouth. The service given to the fishermen consists mostly of auctioning the fish to local buyers, who then sell it to wholesalers at inland markets or in the locality. The fishermen's co-operatives often work in close conjunction with these markets; they sometimes run the

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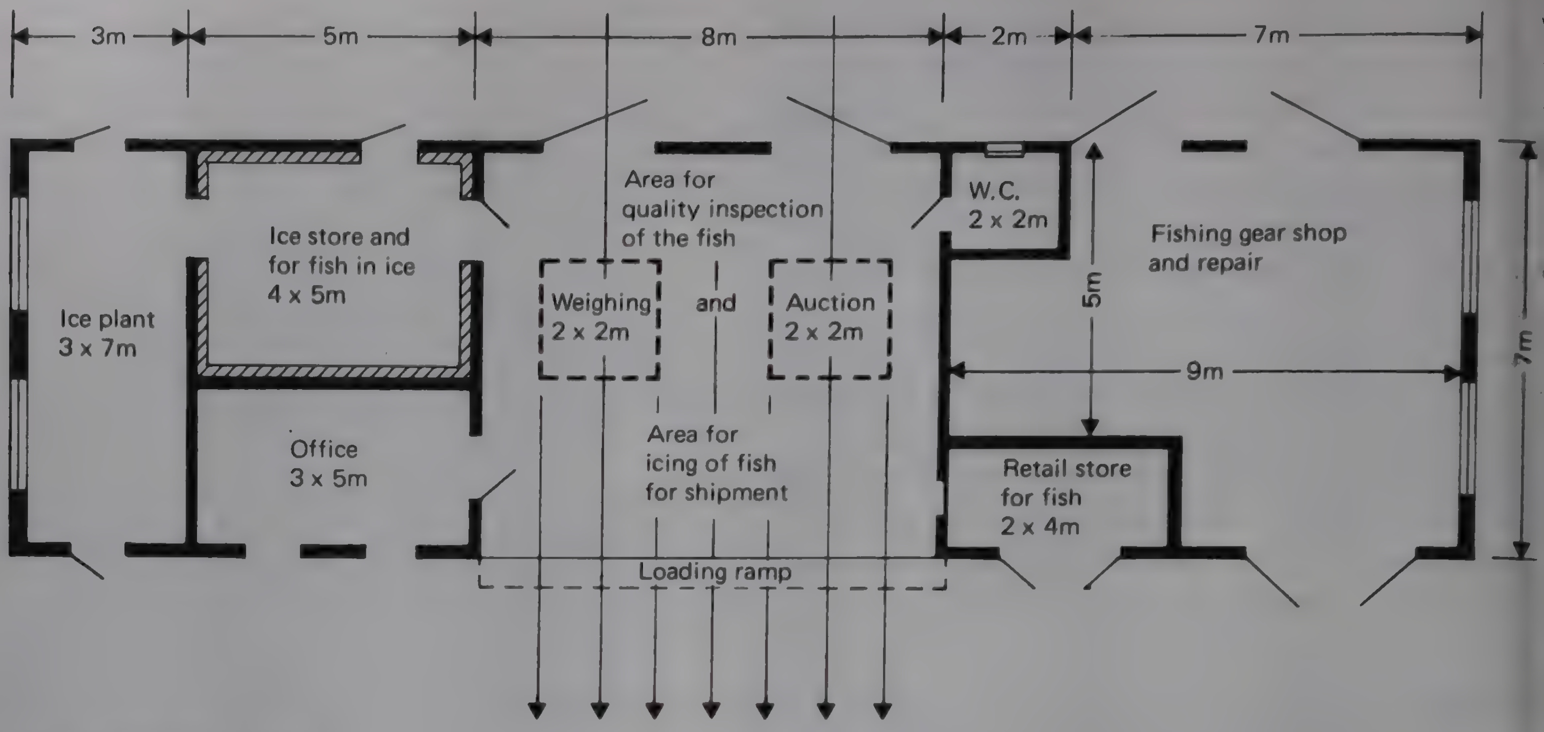
* Zambian Kwacha 0.64 = US $ 1.00, as per February 1975

**Figure 1**
**General arrangement for market place for small-size fish landing centre (service station for sail fishing boats of 3 to 5 gross tonnage).**



Source: Magnusson, 1973

operation and help the fishermen to obtain, among other things, fishing gear through loans which are later repaid by their catch. The suggested general arrangement for a market and service station, shown in Figure 1, is organized to include these two services, and thus differs from the present market places, which usually do not include a fishing gear shop. Another feature is the ice plant which again the present market places do not include. Also in the general arrangement is an ice store, which can be used for occasional storage of iced fish; in such circumstances of infrequent use, separate ice and fish stores are perhaps unjustified. The general arrangement also includes a small retail store for selling fish to people who live in the fishing villages and are not fishermen or from fishermen's families (Magnusson, 1973).

## Suggested investigations and demonstration schemes

Income levels and the price of products are important in determining fish consumption. Increased income or lower prices for fish may result in a substantial shift away from cereals, starchy roots and nuts to fish products. Consumer preferences play an important role in this respect. They have been formed over a long period of time and reflect local availability, regularity of delivery of supplies and the form in which the fish is offered for sale. Availability and character of supplies in the market are, in turn, influenced by the perishability of the fish product. However, even well-established consumer habits may change over a short period as a consequence of advertising and other promotional efforts, and the consumer becomes acquainted with a new product (Magnusson, 1973). These factors should be closely investigated so that the most appropriate approach can be taken to resolve the problems associated with fresh fish from small-scale fisheries.

Work carried out on *Tilapia* in Uganda has shown that a lapse of six hours prior to icing does not significantly reduce the length of storage in ice. If this is true for other species there may be no need to ice the fish immediately after capture but only on landing. This could have enormous advantages in small-scale fisheries. Also, in certain situations, the long shelf life of tropical fish stored in ice may favour the establishment of a distribution network of iced fish rather than development of a freezing operation and distribution of frozen fish. Methods of fish handling developed elsewhere will often be relevant to tropical conditions, but this should not be taken for granted. More information on the spoilage pattern of tropical fish at chill temperatures is needed; this could be particularly useful before embarking upon major improvement schemes (Disney *et al.*, 1974). International, regional and national fisheries development projects in the tropics could be used to collect additional information in a co-ordinated manner. To this end, preparation of a review of the microbiology of species living in warm tropical waters is being undertaken by the Indo Pacific Fisheries Commission under the auspices of FAO.

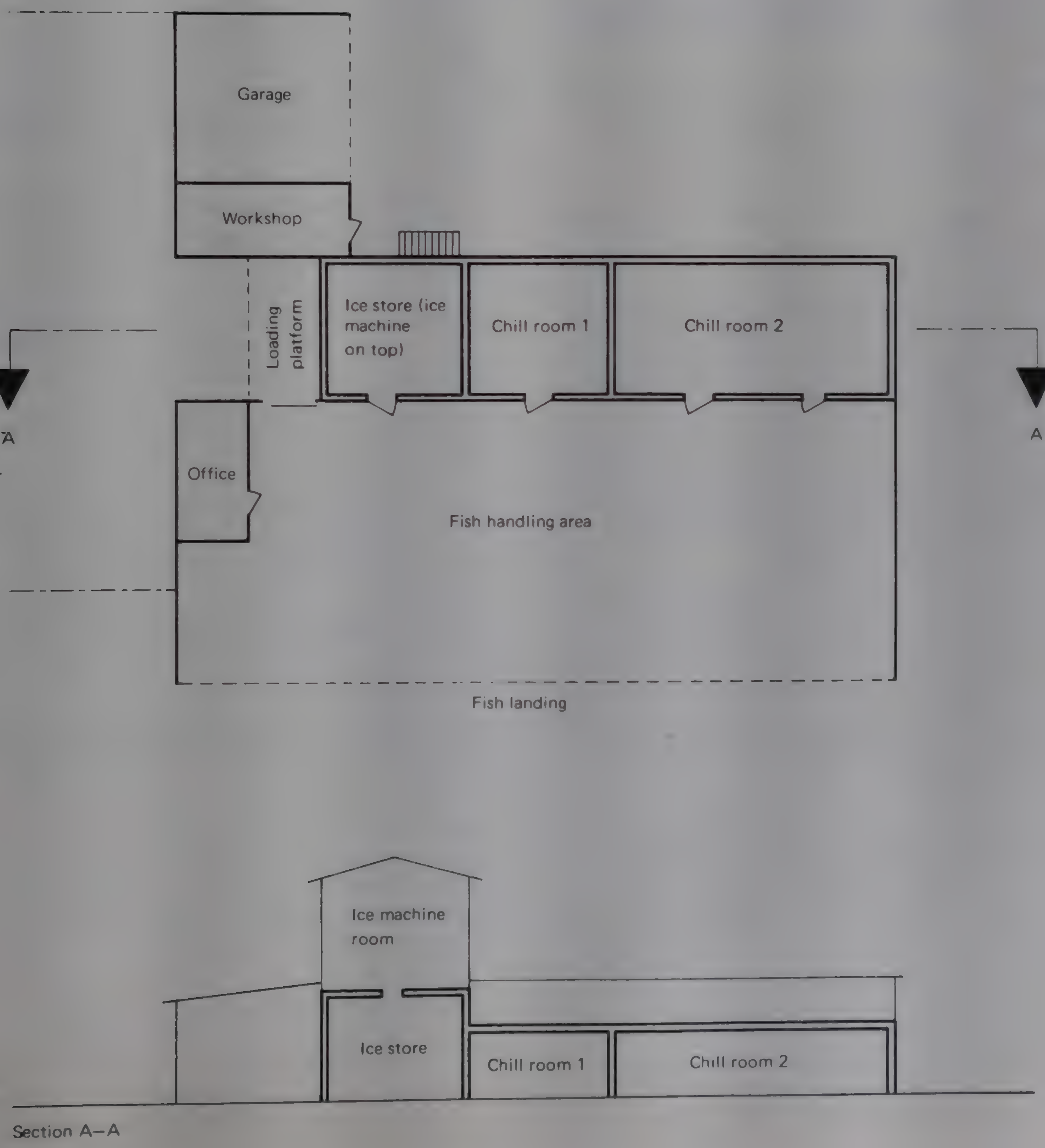
There is controversy on the use of either block- or small-ice in small-scale fisheries. A techno-economic investigation would greatly assist in planning the appropriate type of ice-making facilities for this sector of the fishery. Unfortunately, the benefits of iced storage may, in practice, be severely reduced by the methods of fish capture. For example, the use of fixed gill nets in many African lakes results in dead fish hanging in the net for many hours before they are landed. A modification of this fishing technique, such as the more regular removal of fish from the net, could solve this problem (Disney *et al.*, 1974).

Little work has been reported on the effects of gutting tropical fish in small-scale fisheries. Some findings on East African freshwater fish show that gutting marginally extends the shelf life of iced *Tilapia*, that this improvement does not justify commercial gutting and that gutted fish only rarely meet consumers' acceptance (Disney *et al.*, 1974). More investigations of this aspect of fish handling in the tropics, including marine species, would be desirable. It also seems worthwhile to carry out more investigations in traditional methods of salting, sun drying and smoking of fish (FAO, 1971 b).

A project is being planned with FAO assistance, for one of the West African countries to investigate, assess and demonstrate, on a pilot scale, a feasible landing station for pelagic fish caught by small-scale fishermen. Landing, handling, storage, processing and distribution of fresh fish will be presented as an integrated operation. The results are expected to be expressed in both technological and economic terms.

Due to the lack of facilities for chilling and transportation very small quantities of fish caught in Lake Chad are marketed fresh, the rest are processed into dried and smoked products. As a result of insect infestation, between 30 and 70 per cent of the products deteriorate before they are bought by consumers; this represents a loss of over 10,000 tonnes of fresh fish (valued at more than US $ 2 million). To help overcome this situation a demonstration project, to show that traditional processing can be replaced by fresh fish distribution, was started in Baga on the Nigerian shore of Lake Chad. The core of this project is a fish handling station (Figure 2) to collect, store and distribute fresh fish, from small-scale fishermen, to major distant consumer centres. The station consists of a 10 ton flake ice plant with ice storage and two chill rooms with a combined capacity of 15 tons of iced fish in boxes; a screened and paved fish handling area with ample water supply, as well as facilities to assist the fleet of insulated trucks involved in transporting fish to markets, are also provided. This station will be used for on-the-job training in fish handling practices and as a model for the construction of other stations around the lake.

**Figure 2**
**Layout for fish handling station, Baga, Nigeria. (Not to scale).**



Improvements in fish handling techniques introduced to small-scale fisheries should be simple and should be adapted to the working conditions of the fisherman or fish processor, as well as to the social structure of their communities.

In the artisanal sector the creation of fishery centres, with appropriate handling, storage and processing facilities, as well as training and demonstration arrangements, is necessary. Government action is required particularly in assisting the organizational aspects of fish collection and distribution systems for scattered fish landings. Integrated applied research and the creation of such centres will facilitate the implementation of technical advisory schemes and should ultimately lead to upgrading the artisanal sector to semi-industrial-type operations.

## References

**Abdel-Latif, A. F.** (1974) *Fisheries of Lake Nasser.* Aswan, A. R. Egypt: Lake Nasser Development Centre, 235 pp.

**Aldrin, J. F., Anibroggi, C. & Ponny Assemien F.** (1970) Le test de l'azote basique volatile appliqué à quelques espèces de poissons tropicaux. *Recl. Med. Vet.*, **146** 677–688.

**Amu, L. & Disney, J. G.** (1973) Quality changes in West African marine fish during storage. *Trop Sci.* **15** (2), 125–138.

**Dhatemwa, C.** (1975) Fish processing and marketing in Uganda. Paper presented to the FAO/SIDA Seminar on the Planning and Implementation of Fish Utilization Programmes in Africa, Lusaka, May 1975. No. FII: TFUA/75/C6.

**Disney, J. G., Cameron, J. D., Hoffman, A. & Jones, N. R.** (1969) Quality assessment in *Tilapia* species. In: *Fish inspection and quality control* (ed. R. Kreuzer) pp. 71–72. Surrey: Fishing News (Books)

**Disney, J. G., Cole, R. C. & Jones, N. R.** (1974) Considerations in the use of tropical fish species. In: *Fishery products* (ed. R. Kreuzer) pp. 329–337. Surrey: Fishing News (Books), 463 pp.

**FAO** (1969) *Fisheries survey in the Western and Mid-Western regions Nigeria, Final Report.* Rome: FAO, SF:74/NIR 6, 142 pp.

**FAO** (1971 a) Fishery development prospectives for African countries. Paper submitted to Consultation on the Conservation of Fishery Resources and the Control of Fishing in Africa, Casablanca, May 1971. FID: CFRA/71/6.

**FAO** (1971 b) Equipment and methods for improved smoked drying of fish in the tropics. *FAO Fish. Technol. Pap.* No. 104, 27 pp.

**Feidi, I.** (1975) *Economics of production, transport and marketing of the Lake Nasser Fisheries.* Rome: FAO, FI:DP EGY/66/55812, 79 pp.

**Kristjonsson, H. & Talarczak, K.** (1975) Internal FAO document No. INT/72/074/TRAM/8, 8 pp.

**Lisac, H.** (1974) Small-size ice plants for fishery industries. *FAO Fish. Technol. Pap.* No. 131, 6 pp.

**Maembe, T. W. & Magoha, M. P.** (1975) Utilization of fish in Tanzania Paper presented to the FAO/SIDA Seminar on the Planning and Implementation of Fish Utilization Programmes in Africa, Lusaka, May 1975, No. FII:TFUA/75/C9.

**Magnusson, M. K.** (1971) Transportation and marketing of fish from Lake Nasser. FAO, FI:SF/UAR 58 *Tech. Rep.* 1, 41 pp.

**Magnusson, M. K.** (1973) Marketing of fish in Java. FAO, FI:DP/INS/71/526 *Tech. Rep.* 1, 113 pp.

**Munbodh, M.** (1975) Utilization of fish in Mauritius. Paper presented to the FAO/SIDA Seminar on the Planning and Implementation of Fish Utilization Programmes in Africa, Lusaka, May 1975. No. FII:TFUA/75/C5

**Roach, S. W.** (1974) Preliminary investigations into potential commercial fish landing centres on Lake Victoria. FAO, FI:DP 9/20 RAF 65/049/3, 9 pp.

**Siddiqi, M. I.** (1956) The fishermen's settlements on the coast of West Pakistan. *Schriften des Geographischen Instituts der Universität Kiel,* Fed. Rep. Germany, 86 pp.

**Subba Rao, G. N.** (1967) Fish processing in the Indo-Pacific area. *FAO IPFC Regional Studies,* No. 4.

**Taylor, G. T. & McAlister J.** (1969) A proposal for fisheries development at Kpandu Tokor, Volta Lake. FAO Volta Lake Research Project, Ghana, 8 pp.

**Vidaeus, L. O.** (1975) Marketing strategy, marketing organization and distribution systems in artisanal fisheries development. Burundi FAO–FI:DP/BDI/73/007/1, 72 pp.

**Watanabe, K.** (1965–66) Handling and keeping quality of iced Kariba bream, *Tilapia mossambica. Fish Res. Bull.*, Zambia, **5**, 225.

**Yamamoto, Y.** (1975) A note on alternative fish processing in Kafue River flood plains. Paper presented to the FAO/SIDA Seminar on the Planning and Implementation of Fish Utilization Programmes in Africa, Lusaka, May 1975. No. FII:TFUA/75/S2.

# The handling and transportation of fish in Malaysia

**A. Kamari, A. Z. Idrus and Zahara Merican**
Malaysian Agricultural Research and Development Institute, Malaysia

### Summary

The annual amount of fish landed in Peninsular Malaysia is estimated to be about 430 million kg. It is anticipated that the demand for fresh fish will increase to 700 million kg per year by 1995. The loss in quantity of fresh fish is a serious problem which merits further consideration to ensure adequate supplies of fish. The fishing industry is still considered as a 'small boat' industry. The facilities for landing, handling and distribution are still at the development stage.

The paper reviews the present status of the handling and transportation of fish in Peninsular Malaysia. These activities include handling on board ship, at landing centres, during transportation and at wholesale and retail markets. Problem areas have been identified at these points, one of them being the insufficient use of ice.

### Résumé

La quantité annuelle de poisson débarqué dans la Péninsule de Malaisie est estimée à environ 430 millions de kg. On prévoit que la demande en poisson frais augmentera jusqu'à atteindre 700 millions de kg par an en 1995. La quantité de poisson frais perdu constitue un problème important qui mérite d'être pris davantage en considération pour assurer une production adéquate de poisson. L'industrie de la pêche est encore considérée comme une 'activité artisanale'. Les facilités de débarquement, de manipulation et de distribution sont encore au stade de développement.

L'article passe en revue l'état actuel de la manipulation et du transport du poisson dans la Péninsule de Malaisie. Ces activités comprennent la manipulation à bord, dans les centres de débarquement, au cours du transport et dans la commercialisation en gros et au détail. Des points posant des problèmes ont été déterminés, l'un d'eux étant l'utilisation insuffisante de la glace.

### Resumen

Se estima que la cantidad anual de pescado desembarcado en Malasia Peninsular es aproximadamente de 430 millones de kg. Se prevé que la demanda de pescado fresco aumentará a 700 millones de kg al año en 1995. La pérdida cuantitativa de pescado fresco es un serio problema que merece estudio ulterior para asegurar el adecuado suministro de pescado. La industria pesquera se considera todavía como una industria de 'pequeña embarcación'. Las instalaciones de desembarque, manipulación y distribución están todavía en estado de desarrollo.

Este artículo hace una revisión de la situación actual de la manipulación y transporte del pescado en Malasia Peninsular. Estas actividades incluyen la manipulación a bordo, en los centros de desembarque, durante el transporte y en los mercados al por mayor y al detalle. En estos puntos se han identificado los distintos problemas, uno de los cuales es el uso insuficiente del hielo.

## Introduction

Over the last decade there has been a marked growth in the Malaysian fishing industry. Production in 1974 amounted to 400 million kg while ten years ago the production was below 180 million kg (Anon, 1975). The technology of fish handling, transportation and storage has not changed much over the same period. Technological innovations are not adopted so readily by the fishing industry as by other agricultural sectors. This is largely attributed to the lack of proper landing and storage facilities, the absence of sound marketing procedures and the lack of well-organized fishermen's associations. To aggravate the situation there is insufficient ice to meet the requirement of the industry.

The major part of the catch is marketed fresh although some is processed into frozen products, belacan (a fermented prawn paste), salted fish and dried fish. The use of fish as fertilizer and fish meal has increased with the advent of trawling which brings in a considerable amount of trash fish. Fish used for fertilizer and meal constitute approximately 30% of the total landing. It is interesting to note that trash fish constituted only 40% of the trawl catch in 1970. By 1974 this had increased to 60%. Between 10 and 20% of the trash fish consists of spoilt commercial grade fish.

### *Icing*

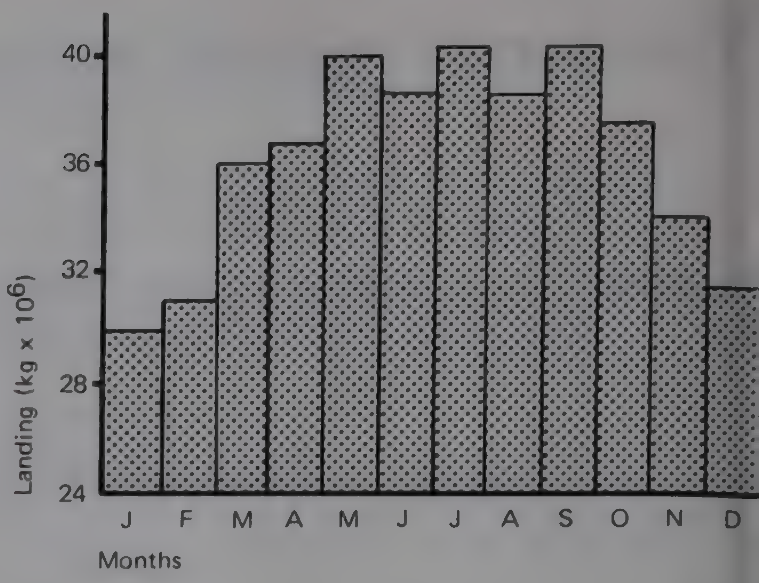
Icing is the common method used to chill the fish during all the stages of handling and transportation, but the annual requirements for ice exceed the present supply by over 400 million kg (Kamari, 1975). The only ice available to the industry is crushed block ice, which is often of very poor quality, there being instances when ice blocks are made from untreated river or well water. Improper handling of ice results in considerable loss through meltage and seasonal variation in the catch also aggravates the shortage of ice. This creates a heavy demand for ice during the peak months from May to September or October (Figure 1).

Table 1 shows the daily production capacities of ice factories for Peninsular Malaysia and the ratio of the availability of ice to amount of fish landed. It is important to note that not all the ice produced is used in the fishing industry. The table helps to identify those areas which are in need of additional ice factories.

The shortage of ice has been discussed earlier; however another contributing factor is the large number of very remote fishing villages where the volume of fish landed is relatively small. It is not economical to transport ice to these areas.

The high cost of ice may be attributed to the oligopolistic nature of the business. The average cost of production for each ton of ice is about US $ 7.50 but the price can be as high as US $ 22.00. This high cost of ice is a burden for the fishing industry (Kamari, 1975).

**Figure 1**
**Landing of marine fish by months in Peninsular Malaysia (1974)**



Fisherman do not appreciate the need to keep their cat cool because visible signs of deterioration do not occur while the fish are on the boat. They are satisfied provided the catch can be sold.

The scarcity and the high cost of ice also encourages th practice of selective icing. High value fish are iced adequately whilst the others are subjected to very little icing or none at all.

The present practice of fish handling and distribution can be divided into four areas; handling on board vessel handling at landing centres, transport between landing and market centres, and handling at wholesale and retai markets.

### *Handling on board vessels*

There are 22,377 licenced fishing boats in Peninsular Malaysia. Eighteen per cent of these are not powered, while another nine per cent are powered by outboard engine. The remaining 73% are inboard powered boats and among these, 32% are under five tons and only 16% are above 15 tons. It can readily be seen that the Malaysian fleet is essentially 'a small boat' fishery.

There are still a number of vessels without proper fish holds; fish is either placed below deck or stored in

TABLE 1. *Production and storage capacity of ice and the ratio of ice to fish (December, 1974)*

| *State* | *Ratio ice:fish* | *Annual amount of fish landed (tons)* | *Daily production of ice (tons)* | *Ice storage capacity (tons)* |
|---|---|---|---|---|
| Trengganu | 1:2.5 | 58,779 | 79 | 164 |
| Selangor | 1:1.7 | 86,807 | 172 | 258 |
| Kedah | 1:0.89 | 41,916 | 153 | 461 |
| Johore | 1:0.5 | 43,108 | 285 | 258 |
| Perak | 1:0.6 | 129,625 | 738 | 2,070 |
| Penang | 1:0.26 | 26,244 | 340 | 323 |
| Kelantan | 1:0.45 | 12,514 | 93 | 169 |
| Perlis | 1:0.33 | 12,296 | 133 | 350 |
| Pahang | 1:0.34 | 18,687 | 181 | 164 |
| Malacca | 1:0.042 | 1,317 | 105 | 170 |
| N. Sembilan | 1:0.026 | 309 | 40 | 15 |
| *Total* | 1:0.63* | 432,642 | 2,229 | 4,402 |

*Average ice to fish ratio.

wooden boxes on deck. Such vessels normally go on daily fishing trips (in coastal waters) seldom lasting more than 8 to 10 hours.

A number of fishing gears are used in the industry. The percentages of the total fish landing by each type of gear are trawl net 43.5%, seine nets 20%, bag nets 8.5%, drift/gill nets 5.5%, lift nets 4.0%, lines 3.5%, traps 3.0% and others 12.0%.

Vessels operating purse seining, trawling and gill netting generally have fish holds but these are usually uninsulated. Block ice is placed in insulated boxes and each block is usually cut into four pieces. In Penang, each 30–50 GRT trawler takes only 270 kg of ice for each trip lasting about 18 hours (Selvadurai and Lai, 1976). The quantity of ice used is very much below the 1:1 ratio.

After the fish are caught, they are placed on deck. The fish are then sorted and placed directly into the containers, which may be below or on deck, with some broken ice; sea-water is sometimes added. The delay between the fish being brought on deck and being placed in the hold depends on the size of the haul and the composition of the catch. Each haul takes about three hours, the whole process of sorting and storing is carried out during this period. Sorting often takes place on the open deck where the fish may be exposed to the sun for a period of four hours before they are iced; the temperature of the deck can be as high as 60–65°C.

Containers used on board vary from small wooden boxes to bamboo baskets of various dimensions. They are very poorly designed and there is no attempt at standardization.

The time-lapse between capture and landing is variable and is largely dependent upon the success of the trip. The ice used is obviously insufficient to control the temperature of the fish between capture and landing and there are sometimes considerable periods of exposure to high temperature. Observations made on prawns (a high priced item) show that only one out of six consignments has ice left when they are landed (TPI, personal communication).

The sea temperature at the surface is approximately 31°C. and the temperature of prawns taken immediately after capture may be as high as 29°C. At the time of capture, it has been found that there are already high levels of bacteria present. For whole prawn, the average total count is 2,803,000 organisms/g. At high ambient temperatures, improper icing and mishandling will result in very rapid quality deterioration and bacterial growth. Sidaway and Balasingham (1971) reported that although fish from tropical waters, when caught, appear to undergo a lag phase similar to that of fish from temperate waters, the effect of direct sunlight and high ambient temperature can cause rapid deterioration. The flesh of fish such as mackerel (*Rastrelliger* sp.), which are full of feed when caught, soon becomes pulpy and soft.

The handling technique on board vessels is poor. The average total count for whole prawns at landing is 10,360,000 organisms/g, a four fold increase from the level at the time of capture (TPI, personal communication). Prawns, being a high price commodity, are given extra icing and care, yet there is a marked increase in the bacterial population. It can be assumed that for the other types of fish the situation is much worse.

### *Handling at landing centres*

There are a few organized landing centres in the country. Fish are, however, still being landed at practically all the fishing villages along the coast.

The packing and transportation of fish from points of landing to large market centres is fairly well organized and those engaged in the business appear to appreciate the importance of maintaining the fish at a low temperature. Packing is sometimes delayed from two to five hours after the fish is landed.

Fish are packed in boxes which are made of local wood. The boxes are of varying size, with capacities ranging from 120 to 240 kg. The boxes are often lined with heavy grade polythene sheets. As the fish are resorted and weighed, they are packed into boxes with crushed ice. Small fish are mixed intimately with ice by stirring them with a wooden paddle as each box is gradually being filled. This, no doubt, cools the fish but the effect on texture has not been ascertained. When the boxes are full, the loose ends of the polythene sheets are folded over and sometimes the boxes are covered. Prawns and certain types of fish are, at times, packed in undrained, galvanized iron containers.

Proper storage facilities at landing centres are either very inadequate or entirely lacking. The general practice is for fish to be consigned directly to market centres without holding them at the landings but, where storage becomes necessary, fish are iced and kept in cold rooms or in the open.

When the fish are kept in wooden boxes for overnight storage, a layer of crushed ice is placed at the bottom of the box. Fish are then layered alternately with ice. The proportion of ice will depend on the distance to the intended market centres; a ratio of 1:1 ice to fish is used for an 18 hour journey and 1:1.5 for a 12 hour journey.

TABLE 2. *Fish storage facilities in Peninsular Malaysia*

| *State* | *Fish cold storage capacity (tons)* |
|---|---|
| Perlis | 3 |
| Kedah | 137 |
| Penang | 7,034 |
| Perak | 1,551 |
| N. Sembilan | – |
| Malacca | 485 |
| Kelantan* | 166 |
| Trengganu* | 127 |
| Pahang* | 159 |
| Johore | 33 |
| *Total* | 14,323 |

*Eastern States

The total cold storage capacity for Peninsular Malaysia is about 14 million kg of fish. Details regarding the location of the cold stores are given in Table 2. It may be noted that the cold storage facilities are concentrated on the west coast and account for 72% of the total. However, these cold stores are mainly used for raw material for the canning and frozen fish industries.

During the Second Malaysia Plan (1971–1975), the Government planned to construct several fishing harbour complexes, including the full range of support facilities, to cater for large fishing boats. To date, two such complexes have been built at Kuala Kedah and Lumut on the west coast of Peninsular Malaysia and one on the east coast at Kuala Trengganu. Two further fishing harbours will be built on the east coast at Chendering and Kuantan. These will be equipped with sophisticated shore support facilities for vessels of up to 200 tons. The two locations for the harbours are in anticipation of developing the South China Sea fisheries (Labon, 1974).

### *Transportation of fish between landing and the market centres*

Shipment is made in trucks on the mainland or by boats from off-shore islands to the mainland. During long distances, the boxes may be opened and re-iced en route. Fish, bound for Singapore from centres on the north east coast, are re-iced at Kuantan. Refrigerated or insulated transport is not used for transporting fresh fish although test runs with insulated transport have shown that less ice is required and icing en route will not be necessary.

The polythene lined boxes and the galvanized iron containers do not allow the melt-water to drain freely. The effect on fish quality may not be too drastic if sufficient ice is used but, with insufficient ice, spoilage will be faster. In the trucks, the boxes are stacked one on top of the other and, once fully loaded, the truck is normally covered with a tarpaulin.

The main market outlets can be as far as 900 km away from the landings and the journey may take more than 15 hours. There is also some fresh fish imported from Southern Thailand. The ambient temperature may range from 24° to 35°C during the transportation period.

The low cost, poor quality boxes, which are commonly used to transport the fish, are related to the system of fish transport within the country. Often empty boxes are not returned to supply centres or are returned for re-use after washing by hosing with cold water only.

In the rural areas, the distribution of fresh fish is very poor due to inadequate transport, storage and distriburion facilities (Wahby *et al.*, 1970). Since ice is expensive in the rural areas, it is seldom used.

### *Handling at wholesale and retail markets*

The urban centres on the west coast of Peninsular Malaysia are the main market outlets for fresh fish originating from both the west and east coasts as well as from Thailand. There are few holding facilities in the wholesale and retail markets, mainly because the general consumer prefers fresh fish as opposed to frozen or chilled fish. On an average day, the major part of a particular consignment of fish will have been cleared by daybreak at the wholesale markets and by the evening of the same day at the retail level. The high priced fish are consumed in the more affluent urban centres and the low priced fish are absorbed by the rural markets. Thus, at the urban centres, fish may be regraded according to their suitability for immediate disposal or for re-consignment to the rural areas.

It is observed that some of the consignments arriving at the Kuala Lumpur wholesale market are beginning to show signs of deterioration. The quality of prawns is poor probably because most of the good quality prawns have been taken by the frozen prawn processors for export.

Consignments coming from distant landing areas such as Dungun, Trengganu and Thailand seem to have ice remaining in the packing boxes but those consignments from landing areas much closer to Kuala Lumpur are at times devoid of ice.

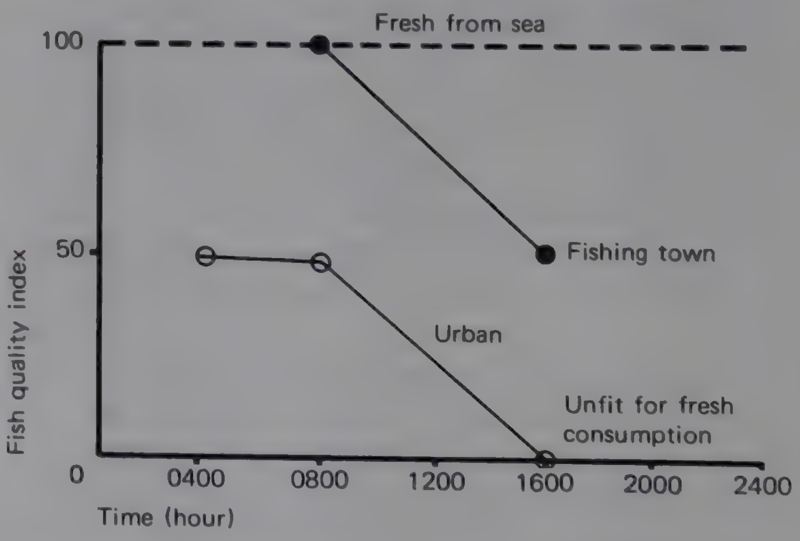
In the wholesale market, some of the small fish and prawns may be partially processed under unhygienic conditions. It is also observed that, at the wholesale level, very little re-icing is done if the fish are to be immediately disposed of to retailers; re-icing is only done if the fish are to be repacked for dispatch to other markets.

The retailers generally do not re-ice the fish except when there is excess ice left behind from the fish boxes; this ice is normally highly contaminated. Fish on display are very seldom iced.

Two recent surveys, conducted to determine the quality of fish at the retail market in the fishing town of Kuala Trengganu (Man, 1975) and at the wholesale and retail markets in Kuala Lumpur (Kamari, 1976), showed the following sequence of deterioration: in the mornings the fish are relatively fresh, by the early afternoon signs of spoilage begin to appear and by the late afternoon most of the fish have greatly deteriorated. Fish with a high fat content, such as *Rastrelliger* spp. (6–8% fat content), are especially susceptible to spoilage under the present market conditions (Balasingam, 1971). Figure 2 shows the rate of deterioration of fish at the retail markets.

**Figure 2**

**Deterioration of fish (*Rastrelliger* sp.) at the retail market**



Many retailers may buy less than 10 kg of each fish type and this makes it necessary for the wholesaler to fully unload each box and discard the little ice that may be left inside.

The display of fish for sale at the retail level leaves a lot to be desired. The un-iced fish are exposed to the sun and laid on the floor or on display slabs. The sanitation of the retail markets is also very poor. Conversely, the situation in the supermarkets, which are now appearing, is considerably improved.

## Conclusion

The problem areas that must be improved are:

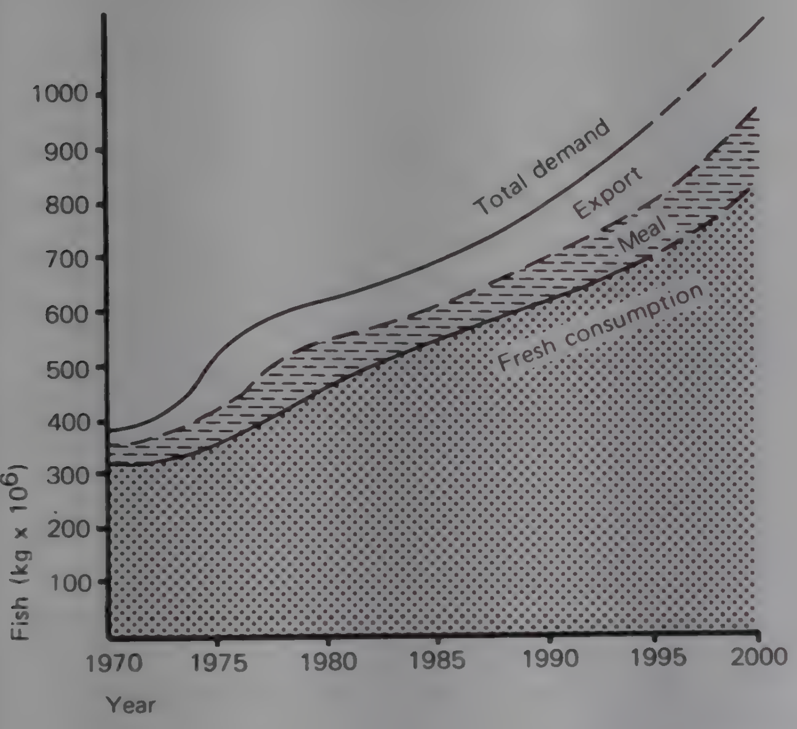
(a) Handling on board ships where there is a need for better designed holds. The education of the fishermen must be intensified so that they will appreciate the need to ice their catch.

(b) Handling at landing centres, the wholesale and the retail markets where the fish must never be allowed to be exposed to the deteremental effect of the high temperature or the unhygienic conditions of the environment.

By the year 1995 the population of the country is expected to double as would the demand for fish. The projected total demand for fish is represented in Figure 3.

**Figure 3**

**Projected demand for fish in Malaysia 1970–1995**



This anticipated increase in the total landing requires proper handling and storage at all stages of the distribution system to avoid losses in terms of quality and quantity. Greater emphasis must be placed on the correct use of refrigeration and handling practices. Intensive research must be carried out to adapt and adopt the existing technology successfully.

Icing is the most usual method of short-term fish preservation. Immediate steps must be taken to ensure sufficient supply of good quality ice to the fishing industry at a more realistic price. To meet the present shortage of ice the immediate investment required is estimated to be US $ 15 million.

## References

**Anon.** (1975) *Annual Fisheries Statistics, Malaysia.*

**Balasingam, M.** (1971) Extraction of oil from marine fish by using various solvent systems and the determination of the iodine value of the extracted oil. *Minist. Agric. Malaysia, Div. Food Technol. Rep.*

**Kamari, A.** (1975) Report to the Task Force on Handling and Transportation of Fish, Malaysia, Ministry of Agriculture, Malaysia.

**Kamari, A.** (1976) Survey of fish quality in Kuala Lumpur. Agricultural Product Utilisation Division, MARDI, Malaysia (To be published).

**Labon, A.** (1974) Malaysian long-term Fisheries Development Plan until 1995. *FAO/UNDP Report.*

**Man, Y. C.** (1975) Practical training report, MARA Institute of Technology, Malaysia (Unpublished).

**Selvadurai, S. & Lai, A. K. K.** (1976) Marine fish trawling in Peninsular Malaysia: a case study in costs and earnings (To be published in *Malays. Agric. J.*)

**Sidaway, E. P. & Balasingam, M.** (1971) Fish processing industry in West Malaysia. Food Technology Research and Development Centre of Malaysia. Working paper No. 51, 40 pp.

**Wahby. O, Eriksen, C. G. & Ahmad, S. B.** (1970) Fish processing industry in West Malaysia with special reference to Treggganu. Food Technology Research and Development Centre of Malaysia. Working paper No. 31, 72 pp.

# Fish marketing conditions of Ashar (Basrah, Iraq) fish market

**S. K. Al-Nasiri and K. P. Sharma**
University of Basrah, Iraq

## Summary

The study relates to the wholesale and retail marketing of fish in Ashar fish market, Basrah, Iraq. Detailed observations and discussions are made on the marketing conditions of fish from the fisherman to the consumer level. Most of the profit was taken by the commission agent or the middleman. Before February 1975, there were three stages of intermediaries between the fisherman and the consumer. Since February 1975, the State Fishing Company, a Government agent, has replaced one intermediary and as a result both the fisherman and the consumer benefit. The price structure and the quantity of each species of fish brought to the market during the period of study were reported. Seasonal variations of both marine and freshwater fish were recorded. Finally, recommendations are made for measures to overcome the difficulties and problems now prevailing in the fish marketing system.

## Résumé

Cette étude fait état de la commercialisation en gros et au détail du poisson au marché du poisson d'Ashar, Basrah, Irak. Une étude détaillée et des discussions sur les conditions de la commercialisation du poisson depuis le pêcheur jusqu'au consommateur sont faites. La plupart des bénéfices ont été réalisés par l'agent de commission ou l'intermédiaire. Avant février 1975, existaient trois niveaux d'intermédiaires entre le pêcheur et le consommateur. Depuis février 1975, la Compagnie de Pêche Nationale, agent du Gouvernement s'est constituée comme un de ces intermédiaires avec pour conséquence un avantage pour le pêcheur et le consommateur. Ont été examinés les prix et la quantité de chaque espèce de poisson livrée au marché pendant cette période d'étude. Les variations saisonnières des poissons d'eau de mer et d'eau douce ont été notées. Enfin, des recommantations sont faites concernant les mesures destinées à résoudre les difficultés et les problèmes qui se posent actuellement dans le système de commercialisation du poisson.

## Resumen

El estudio trata de la comercialización al por mayor y al por menor en el mercado de pescado de Ashar, Basrah, Iraq. Se incluyen observaciones detalladas y discusiones sobre las condiciones de la comercialización del pescado desde el pescador hasta el consumidor. El mayor beneficio queda en manos de los agentes a comisión o de los intermediarios. Hasta Febrero de 1975 existían tres estadios intermediarios entre el pescador y el consumidor. Desde Febrero de 1975 la Compañia Pesquera Estatal, agente del Gobierno, ha reemplazado a un intermediario y como consecuencia se benefician ambos, el pescador y el consumidor. Se informa sobre la estructura del precio y la cantidad de cada especie de pescado que llega al mercado durante el periodo del estudio. También se incluyen las variaciones estacionales del pescado de mar y de agua dulce. Finalmente, se hacen recomendaciones en cuanto a medidas encaminadas a superar las dificultades y problemas que actualmente prevalecen en el sistema de comercialización del pescado.

## Introduction

The city of Basrah has a population of 669, 479 (Anon, 1974). Its wholesale fish market is in Ashar and is the second largest in the country, handling some 1,557 tons of fish per annum (Andersskog, 1966). When the auction is finished, the fish are taken from Ashar to other markets at Basrah, Abu Al-Khasib, Makel, Tannuma, Wanbi, Zuber, Jamohria, Khansamur and Qurna for retailing. When the supply is in excess, fish are sent to such places as Baghdad, Amara, Kut, Nasarya etc. Before February 1975, the fish market was in a brick building with sheet roofing, only half of which was used for the wholesale trade. The front of the building was open and the market was quite dirty. Although water was available, floors and walls were washed only occasionally. In February 1975, the market was moved to a new building constructed by the Government. The building has a series of shops systematically arranged and made of concrete. For the time being, 44 shops have been rented by the Government at a monthly rent of three Iraqi Dinars (ID)* each. These shops are supplied with electricity, wash-basins and piped water.

## Material and methods

Fish marketing surveys in Ashar, Basrah, were conducted from August 1974 to September 1975. The fish receipts at the market were ascertained at regular intervals each month. Fish were separated and categorized by species before being made into batches of approximately 25 kg each. The numbers of fisherman, wholesalers and retailers taking part in the auction were counted on the different occasions. A record of the price range of the fish was kept from 5 am until 7 pm on the sampling days.

Five days of each month were selected for fish marketing surveys. The days were picked by rotation so as to avoid bias in the arrivals of the fish.

## Observations

### *Fish species*

Both freshwater and marine fish are sold in Ashar fish market. The freshwater fish come either from Shatt Al-Arab, irrigation canals or from the nearby marshes.

The freshwater fish of importance found in the market are as follows:

| *Scientific name* | *Local name* |
|---|---|
| *Barbus sharpeyi* Gunther | Bunni |
| *Barbus xanthopterus* Heckel | Gattan |
| *Barbus luteus* Heckel | Hamri |
| *Barbus grypus* Heckel | Shabout |
| *Mugil hishni* Misra | Khishni |
| *Mugil dussumieri* Cuvier and Valenciennes | Beeah |
| *Aspius vorax* Heckel | Shillig |
| *Cyprinus carpio* Linnaeus | Common carp |

The marine fish which come from Fao are as follows:

| | |
|---|---|
| *Hilsa ilisha* Ham. and Buch. | Sboor |
| *Stromateus niger* Euphrasen | Grey pomfret |
| *Pampus argentius* Euphrasen | Brown pomfret |
| *Sparus berda* Forskal | Shanak |
| *Brachirus orientalis* Bloch and Schiner | Oriental sole |
| *Chirocentrus dorab* Forskal | Silver bar |
| *Pseudosciaena aneus* Bloch | Jewfish |
| *Ilisha filigera* Cuvier and Valenciennes | Jewelled shad |
| *Caranx kalla* Cuvier and Valenciennes | Haman |
| *Nematolosa nasus* Bloch | Long grey bony bream |
| *Penaeus* spp. | Shrimp |

Of these, sboor is also caught from Shatt Al-Arab and its tributaries near Basrah.

### *Marketing conditions*

Boats and nets are supplied to the fishermen by money-lenders, who charge as much as one third of the catch. The fishermen get loans in cash or kind from money-lenders. A money-lender could be a person from the boat and net owners, the commission agents or the wholesalers. The fish caught by the fishermen pass through several intermediaries before reaching the consumer. The different stages of handling are: fishermen, commission agents of the wholesalers, wholesalers, retailers and consumers. The commission agents buy the catch from the fishermen at convenient places. The agents get labour charges varying from 0.2 ID to 0.3 ID per 25 kg of fish in addition to the transport charges which are fixed by the wholesalers.

### *Wholesale and retail marketing*

The fish are brought to the market, mainly during the night, by the wholesalers agents. Once in the market-place, each of the agents heaps the fish in the open space on the floor, generally without ice, and covers them with plastic sheets. They remain near their fish until it is auctioned. Before the auction, fish are separated according to species and size. Fish of the same size and species are put into date-leaf baskets of approximately 25 kg capacity and displayed ready for auction. Shrimp are auctioned in heaps of 3 kg each. Once the fish are on display, the officials of the State Fishing Company begin to arrive. Usually, one type of fish is auctioned by one team of officials. A team includes one caller, one clerk, to record the rate and issue receipts, and one person to collect money.

The most economically important fish such as gattan, bunni, sboor, silver bar, shanak and hamam are auctioned first. When the auctions are at their peak, the market is so crowded that it becomes very difficult for free movement among auctioneers, retailers and the other personnel involved in the marketing business. The wholesale price usually depends upon species, size and quality of fish. The retailers assess the quality of the fish by touch or by observing the condition of gills and only then start bidding.Unsold fish are kept in ice and covered with a plastic sheet to be sold the next day. Usually, day-old iced fish sell at a lower price than freshly arrived fish.

The agencies which are responsible for transporting fish to the wholesale market usually apply less ice than the retailers. Ice is used only after April by the wholesalers.

After a few batches have been auctioned individually, the remaining batches are allotted, only to certain people, at the same auction rates. At times, this practice causes discontentment among the retailers. Sometimes fish are sold by middlemen, without the knowledge of the officials, on the pretext that these were of insignificant value.

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*Iraqi Dinar (ID) = £1.68 at June 1976.

Successful bidders put the fish in jute bags and carry them to their own selling place or outside the market. Quite often the fish are laid on dirty plastic sheets. The retailers, after purchasing fish, wash them in dirty water and heap the surplus in wooden boxes, often with little or no ice. The retailers apply salt after removing the visera by a vertical cut, but this occurs only when the retailers feel that the fish are deteriorating. After selling the fish, most of the retailers remove the visera before giving them to the buyer. The retailers, who have a small consignment, tie six to ten fish (approximately 1 kg) together through the operculum, and sell them in a bunch. Sometimes fish in pairs weighing 0.5 kg are tied together and sold. Bigger fish are usually kept in cold water, without ice, in round or rectangular containers.

Some fishermen and women are also observed selling fish in the evening on the roadside outside the market area. The condition of fish in such cases is poor and they are small.

After the market was shifted to its new position, a few shop owners in the retail market kept one or two deep freezes for storing excess quantities of fish which were not sold on the previous day.

The retailers are more active on Fridays than on any other day of the week. They use ice mostly for fish which are about to deteriorate or those which are dearer on the market.

### *Wholesale and retail prices*

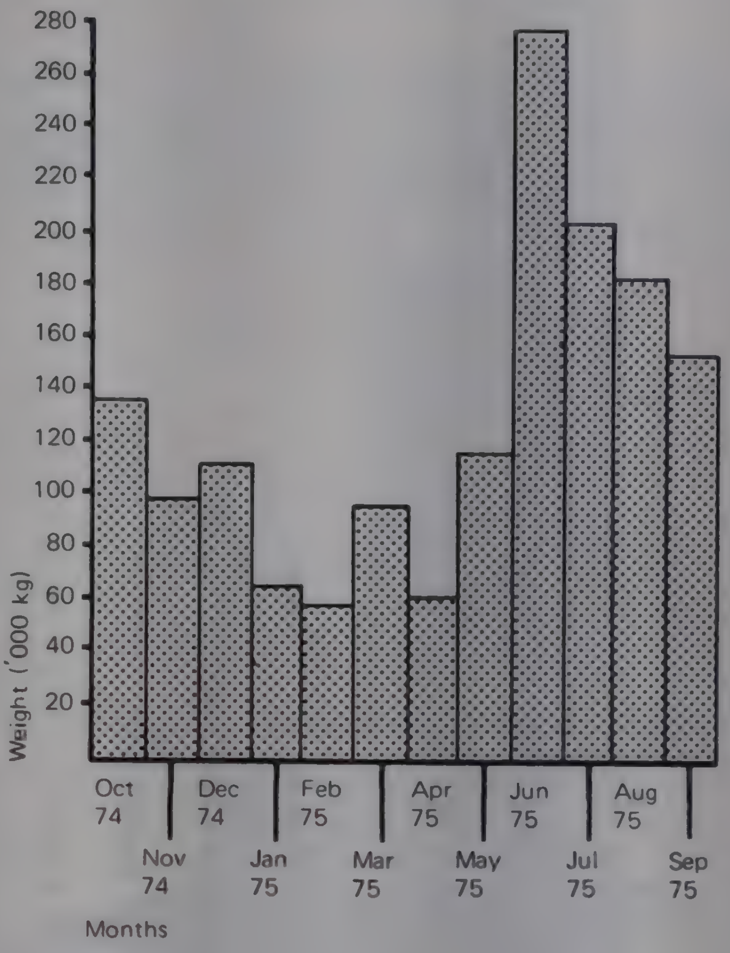
Gattan is the most valued fish and fetches a high price, closely followed by bunni, pomfret, sboor, common carp and shabout. Gattan and bunni of medium size are commonly mixed and sold for auction. These fetch a price equivalent to that of a good-sized shabout. The other fish, in order of importance, are beeah, shillig, khishni, long grey bony bream and silver bar. As a marketing tactic, fish fetching a low price are often mixed with high grade fish for wholesaling. As a result, the poorly graded fish fetch as much as the high grade fish. In this way, hamri-gattan, khishni-hamri and bunni-gattan are sold mixed. Small sized shrimps fetch a low price as compared to the big ones. Usually, the prices for shrimp are very close to hamri, shillig and khishni.

In the wholesale market, the prices generally remain static except when the fish are received in smaller quantities than usual. The prices in the retail market drop throughout the day. The fish sold up to 12 noon are better priced than those sold later in the afternoon; this is due either to loss of quality or the fish being small or the retailers wishing to leave.

### *Catch statistics*

The highest quantity of fish is received in the month of June with a slow decline until November (Figure 1). As far as the quantitative catch of individual fish species is concerned, gattan, bunni, hamri, shabout, khishni and shillig have a regular year-round supply. On the other hand, the catches of sboor, jewelled shad, pomfrets, silver bar, hamam, long grey bony bream, jewfish, oriental sole, common carp, beeah and shrimp fluctuate, with the largest supply in June.

**Figure 1**
**Quantity of fish received monthly at Ashar Fish Market**



Bunni is the largest catch, followed by sboor and gattan (Figure 2). The annual catches of jewelled shad, khishni, shillig, silver bar, pomfrets, jewfish, long grey bony bream and shabout are between 76,653 and 22,829 kg. The annual catches of common carp and hamam are 3,272 and 2,988 kg respectively. The other fish (shanak, oriental sole etc) and shrimp contribute nearly 52,745 and 12,055 kg respectively.

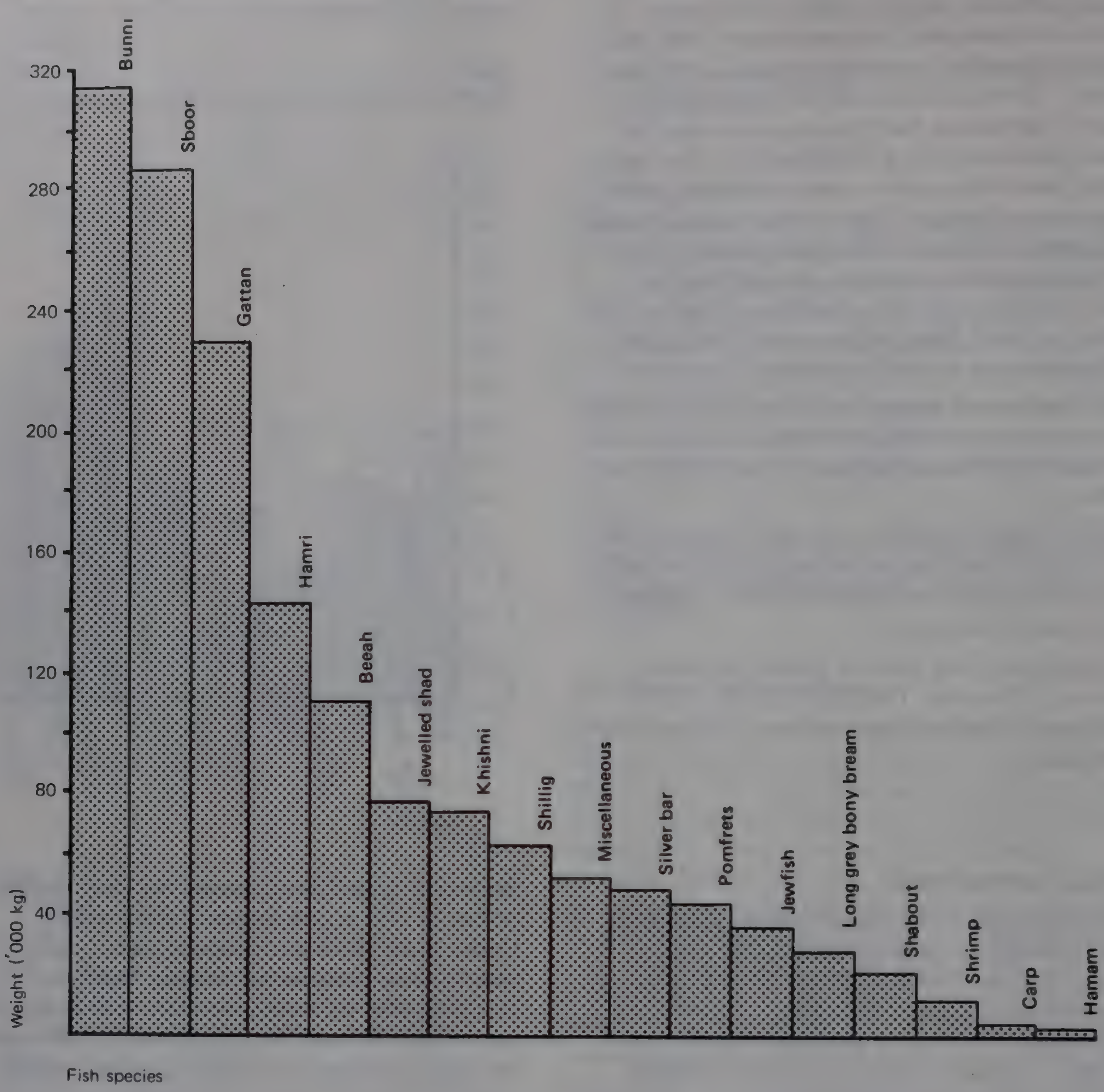
### Discussion and suggestions

The marketing of fish was very unsatisfactory before the market was moved. A large portion of the catch was distributed among various middlemen until it reached the consumers. The middlemen took a huge commission from the fishermen until the catch was sold.

The demand for fish is practically the same throughout the year. However, the supply of fish has always fluctuated, sometimes to less than the demand. Investigations were made into the reasons behind the poor supply of marine fish, including shrimp, particularly during winter. Whether this was due to poor availability of fish in fishing grounds, in the Gulf and marshes or due to the inadequacy and inefficiency of the fisherman or both is not known for sure.

The Government started maintaining a reasonable controlled price after the market shifted to a new site. To achieve these objectives, the Government took certain steps to safeguard the interests of the producers and the consumers with the help of the State Fishing Company.

Figure 2
Quantity of fish received annually at Ashar Fish Market



The Company has partly taken over wholesale marketing and they charge only nominal rates for their labour at the auction. The present system has helped the fishermen, who get a reasonable price for the product, and the consumers who get fish at cheaper rates. The middlemen, who used to make handsome profits at the auctions, have now lost this influence. The Company is now stressing the importance of using price tags in retail shops and this has received a favourable response from the fishermen.

Although the Government is trying hard to improve the fish marketing conditions, it is still left with some major bottlenecks. Important among them are the following:

1. Quite often only few batches of a consignment are auctioned and the rest of the identical catches are distributed among certain people at the same auction rates. Under these conditions, the weaker section of retailers is deprived of the fish from the wholesale trade.
2. The State Fishing Company has not yet been successful in stopping the fishermen from catching small sized fish like gattan, bunni and shabout. The small-fish do not fetch a good price and at the same time provide the possibility of depletion in a particular fishery.
3. In all the principal fishing areas, including the marshes and Fao, there are no landing or storing facilities of any kind. The fishing boats also have inadequate space for bringing the fish to the landing sites. Transportation of fresh fish from the landing areas to the market is often by ordinary trucks or lorries, resulting in deterioration of about 20% of the total catch. A sufficient quantity of fish could be saved from spoilage if the transportation was by insulated or refrigerated untis. It is absolutely necessary to use standardized fish boxes, preferably made of plastic or aluminium, for transporting fish to the marketing station.
4. The wholesale fish marketing facilities are still very unsatisfactory. There is neither cold storage, sufficient auction space nor facilities for ice making, in spite of summer temperatures often exceeding 45°C. Proper storage facilities are needed for the fish before auctioning. The people in the fish trade should be taught to handle fish properly.

5. As is recommended by Van Heck (1973), that information be obtained on the present living conditions of fishermen – their fishing areas, social categories, leaders, boats and gear, production, transport facilities, income and also on their attitudes, needs and desires for living.
6. At present there are less workers assigned to the study of socio-economics and marketing than to the biological aspects of the fishery. The Government should intensify their investigations into the economics of fisheries and social aspects of fishermen.

## References

**Andersskag, B. J.** (1966) Iraq: Preliminary fishery survey: Report to the Government. *FAO/UNDP Report* No. TA2226, p. 8. Rome: FAO, 12 pp.

**Anon.** (1974) *Annual Abstract of Statistics*, p. 28. Planning Ministry, Iraq.

**Van Heck, B.** (1973) Arab Republic of Egypt – settlement of the Lake Nasser fishermen. FAO/UNDP Project EGY/66/558. *Lake Nasser Development Centre, Aswan. Tech. Rep.* No. 3, P. 82. Rome: FAO, 91 pp.

# Development possibilities for wholesaling and retailing fish in the Caribbean

**J. F. Arrundale**
British Development Division in the Caribbean, Barbados

**Summary**

This paper attempts to give simple and, of necessity, sometimes conjectural guidelines for the operation of fish wholesaling depots and retail marketing outlets, suitable for both the larger countries such as Trinidad, Barbados, Guyana and Jamaica and the smaller island countries such as the Windward/Leeward Islands. Particular emphasis has been placed on theoretical cost and viability studies which, it is hoped, will be used as a basis for specific planning requirements and funding needs in individual countries.

**Résumé**

Dans cet article, on essaie de donner des indications simples et quelquefois conjecturales concernant les opérations de vente du poisson en gros et de débouchés commerciaux de vente au détail convenant à la fois à des pays importants comme Trinidad, Barbados, la Guyane et la Jamaïque, et de petites îles telles que les Iles Windward/Leeward. On a insisté tout particulièrement sur le coût théorique et les études de viabilité qui, espère-t-on, seront utilisées comme base pour la mise au point des plans spécifiques et des besoins financiers de chaque pays.

**Resumen**

El artículo trata de dar directrices sencillas y, necesariamente, algunas veces conjeturales, para las operaciones de los almacenes de venta al por mayor de pescado y los establecimientos de venta al por menor, que sean adecuadas tanto para los países grandes, como Trinidad, Barbados, Guayana y Jamaica, como para los pequeños países isleños como las Islas Windward/Leeward. Se concede particular importancia a los estudios de viabilidad y de costos teóricos, que se espera sean aplicados como base de las necesidades de financiación y de los requisitos de planificación específicos en los distintos países.

## Introduction

More than 300,000 tonnes of fish are landed in the Caribbean per annum and the projected requirements for 1985 are over 400,000 tonnes.

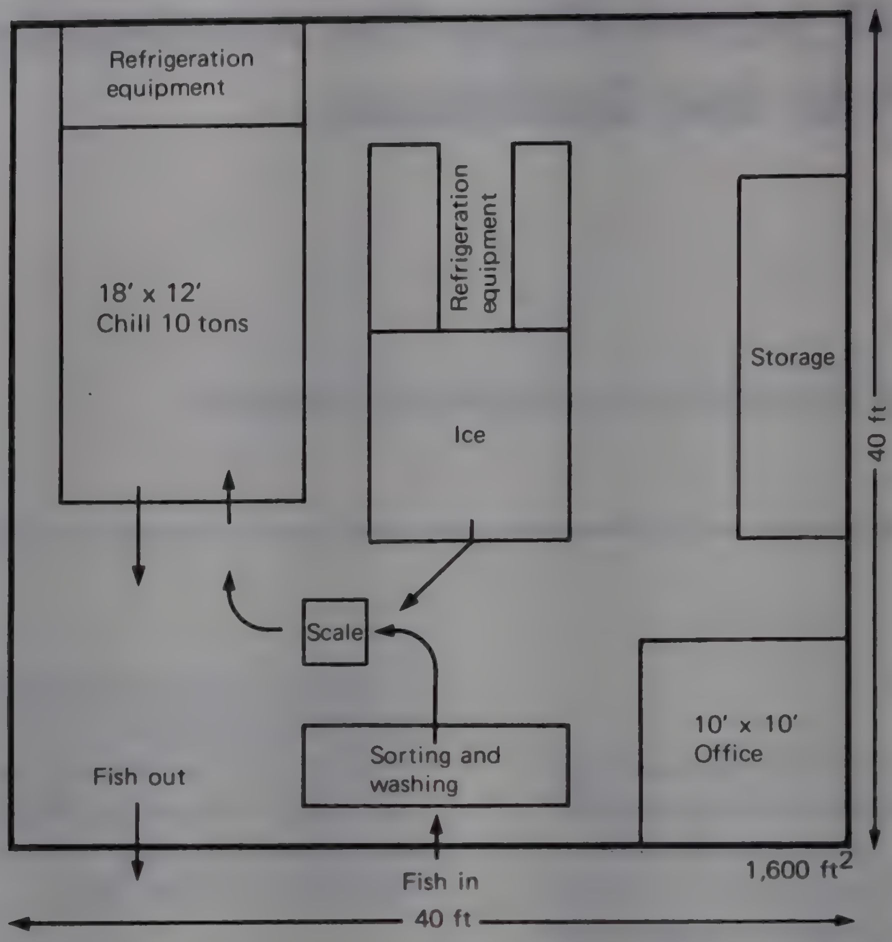
A considerable fish resource has been identified by the UNDP/FAO Fisheries Development Project (Rathjen *et al.*, 1968) which would cover these requirements.

However, there is a growing awareness that the marketing infrastructure throughout the area for fresh or frozen fish, for sale as 'fresh', is inadequate. With one or two notable exceptions, there are no modern, well equipped, wholesale depots as such and existing fish markets are poorly maintained, planned and equipped (Videaus, 1971b).

This paper attempts to give simple and, of necessity, sometimes conjectural guidelines, for the operation of fish wholesaling depots and retail marketing outlets, suitable for both the larger countries such as Trinidad, Barbados, Guyana and Jamaica, and the smaller island countries such as the Windward/Leeward Islands. Particular emphasis has been placed on theoretical cost and viability studies which it, is hoped, will be used as a basis for specific planning requirements and funding needs in individual countries.

This paper is based on work carried out while the author was assigned to the FAO Fisheries Project 1968–1971. It is a virtual combination of two Project Documents (Arrundale and Girigorie, 1970; Arrundale, 1971). The costings and capital requirements are obviously out of date but could, nevertheless, provide a base which can be updated to present costs. Although this is essentially a paper dealing with the Caribbean it is hoped that the basic ideas and suggestions are applicable in other developing countries.

Figure 1
Wholesale depot of 1 ton per day capacity


Refrigeration equipment
18′ x 12′
Chill 10 tons
Refrigeration equipment
Ice
Storage
40 ft
Scale
10′ x 10′
Office
Sorting and washing
Fish out
Fish in
1,600 ft²
40 ft

**General specifications for wholesale depots (Figures 1, 2 and 3)**

**Pre-fabricated building: 20 ft to top of roof**

**Walls: 6 ft (washable), the remainder open mesh or brickwork**

**Drains: open channel with steel covers**

**Floor: rough finished concrete**

**Iron mesh security doors**

Figure 2
Wholesale depot of 5 tons per day capacity

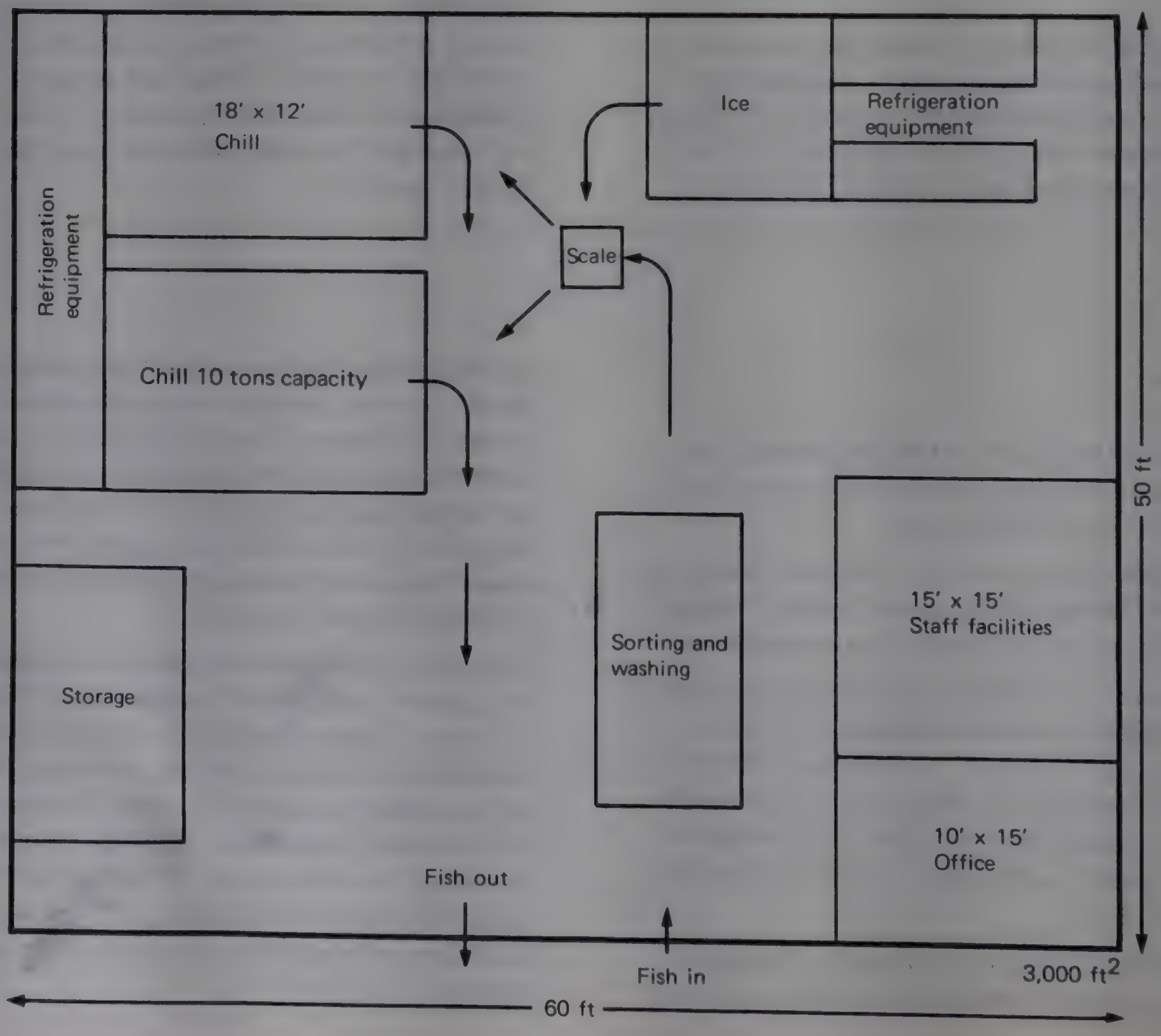

18′ x 12′
Chill
Ice
Refrigeration equipment
Refrigeration equipment
Scale
Chill 10 tons capacity
50 ft
15′ x 15′
Staff facilities
Storage
Sorting and washing
10′ x 15′
Office
Fish out
Fish in
3,000 ft²
60 ft

Figure 3
Wholesale depot of 10 tons per day capacity

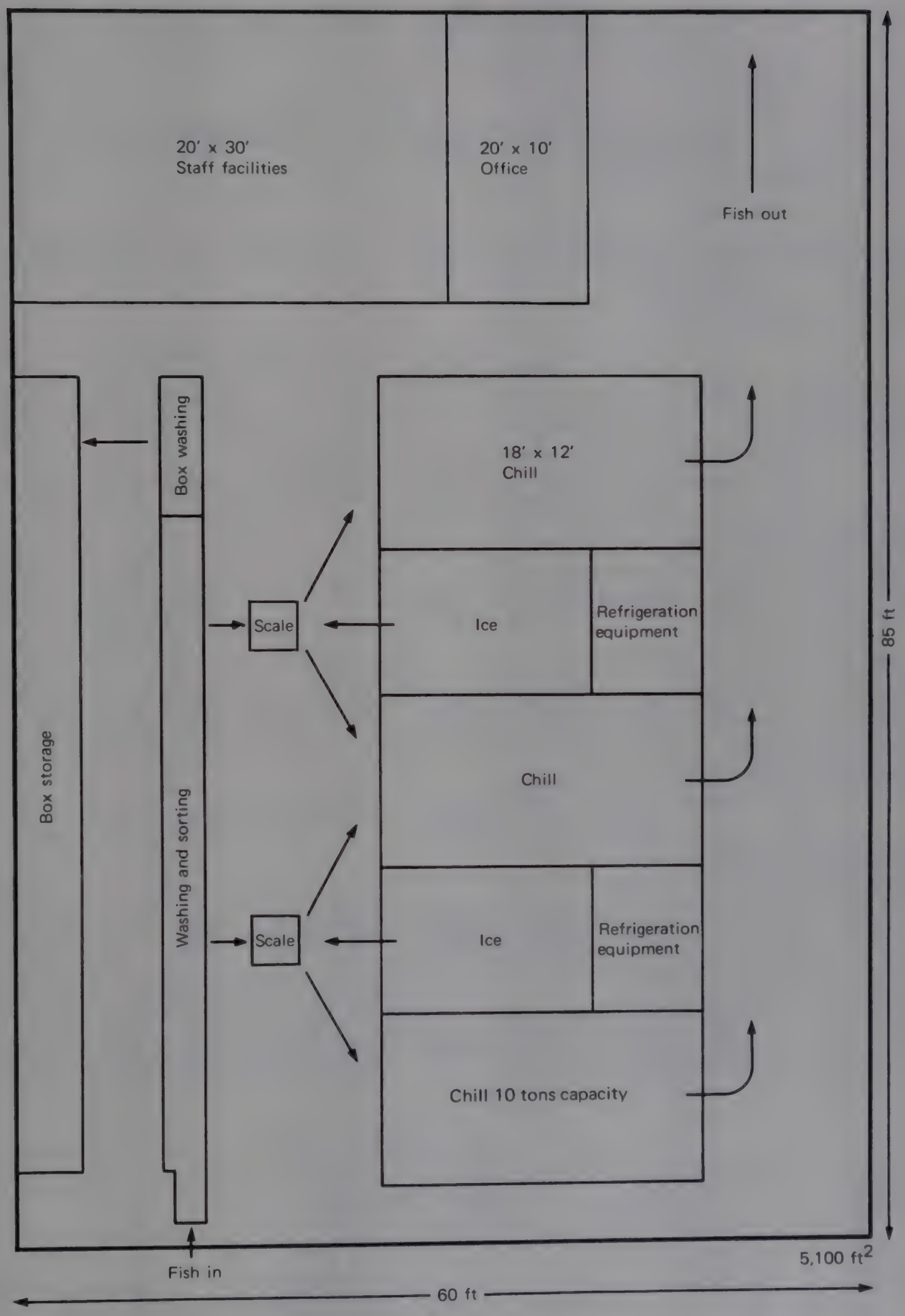

20′ x 30′
Staff facilities
20′ x 10′
Office
Fish out
Box washing
Box storage
Washing and sorting
Scale
Scale
18′ x 12′
Chill
Ice
Refrigeration equipment
Chill
Ice
Refrigeration equipment
Chill 10 tons capacity
85 ft
Fish in
5,100 ft²
60 ft

TABLE 1. *Fish wholesale depot*

| *Theoretical costings* | *1 ton/day 250–day year = 560,000 lb/year* | | | | *5 ton/day = 2,800,000 lb/year* | | | | *10 ton/day = 5,600,000 lb/year* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Buying price* | 25¢ | | 45¢ | | 25¢ | | 45¢ | | 25¢ | | 45¢ | |
| *(EC $)* | *$10^3$ $* | *¢/lb* | *$10^3$ $* | *¢/lb* | *$10^3$ $* | *¢/lb* | *$10^3$ $* | *¢/lb* | *$10^3$ $* | *¢/lb* | *$10^3$ $* | *¢/lb* |
| *Prime costs* | | | | | | | | | | | | |
| Purchase of fish | 140 | 25.00 | 252 | 45.00 | 700 | 25.00 | 1,260 | 45.00 | 1,400 | 25.00 | 2,520 | 45.00 |
| Labour | 22 | 3.90 | 22 | 3.90 | 66 | 2.34 | 66 | 2.34 | 102 | 1.83 | 102 | 1.83 |
| Transport | 6 | 1.00 | 6 | 1.00 | 47 | 1.67 | 47 | 1.67 | 94 | 1.67 | 94 | 1.67 |
| Maintenance | 1 | 0.24 | 1 | 0.24 | 3 | 0.10 | 3 | 0.10 | 5 | 0.08 | 5 | 0.08 |
| Running expenses | 6 | 1.00 | 6 | 1.00 | 28 | 1.00 | 28 | 1.00 | 56 | 1.00 | 56 | 1.00 |
| 5% loss of fish | 7 | 1.25 | 13 | 2.25 | 35 | 1.25 | 63 | 2.25 | 70 | 1:25 | 126 | 2.25 |
| Sub-total | 181 | 32.39 | 300 | 53.39 | 878 | 31.38 | 1,466 | 52.36 | 1,727 | 30.83 | 2,903 | 51.83 |
| 10% contingencies | 18 | 3.24 | 30 | 5.34 | 88 | 3.14 | 147 | 5.24 | 173 | 3.08 | 290 | 5.18 |
| *Total prime costs* | 199 | 35.63 | 329 | 58.73 | 966 | 34.50 | 1,613 | 57.60 | 1,899 | 33.92 | 3,193 | 57.02 |
| *On-costs* | | | | | | | | | | | | |
| Management 10% of prime costs | 2 | 0.36 | 3 | 0.59 | 10 | 0.34 | 16 | 0.58 | 19 | 0.34 | 32 | 0.57 |
| Plant and equip. depreciation 10% | 3 | 0.48 | 3 | 0.48 | 5 | 0.19 | 5 | 0.19 | 9 | 0.16 | 9 | 0.16 |
| Building depreciation 5% | 2 | 0.29 | 2 | 0.29 | 3 | 0.11 | 3 | 0.11 | 5 | 0.09 | 5 | 0.09 |
| Working capital at 8% | 1 | 0.17 | 2 | 0.30 | 5 | 0.17 | 8 | 0.30 | 9 | 0.17 | 17 | 0.30 |
| *Total on-costs* | 7 | 1.28 | 9 | 1.65 | 23 | 0.81 | 33 | 1.18 | 43 | 0.76 | 63 | 1.13 |
| *Total costs* | 206 | 36.91 | 338 | 60.38 | 989 | 35.31 | 1,646 | 58.79 | 1,942 | 34.68 | 3,256 | 58.14 |
| *Profit* | | | | | | | | | | | | |
| 20% on building/plant capital | 12 | 2.10 | 12 | 2.10 | 23 | 0.81 | 23 | 0.81 | 39 | 0.69 | 39 | 0.69 |
| *Wholesale cost* | 218 | 39.01 | 350 | 62.48 | 1,012 | 36.13 | 1,668 | 59.59 | 1,981 | 35.37 | 3,295 | 58.83 |
| 25% retail mark-up | | 9.75 | | 15.62 | | 9.03 | | 14.90 | | 8.84 | | 14.71 |
| *Retail price:* | | 48.76¢ | | 78.10¢ | | 45.16¢ | | 74.49¢ | | 44.21¢ | | 73.54¢ |

## The wholesale operation

The wholesaling operation is defined, for the purposes of this exercise, as: receiving fish delivered from fishing vessels or carrier vessels, sorting, washing, weighing, boxing, icing and storing them for subsequent distribution to retailers and retail outlets. No consideration is given to the costs of unloading vessels or quayside operations due to the diversity of methods, locations and facilities encountered throughout the region.

### *Fish wholesale depot*

Figures 1, 2 and 3 give basic layouts of depots suitable for handling a daily throughput of 1, 5 and 10 tons, respectively. A flow chart is produced as Figure 4.

**Figure 4**
**Flow chart — wholesale depot**

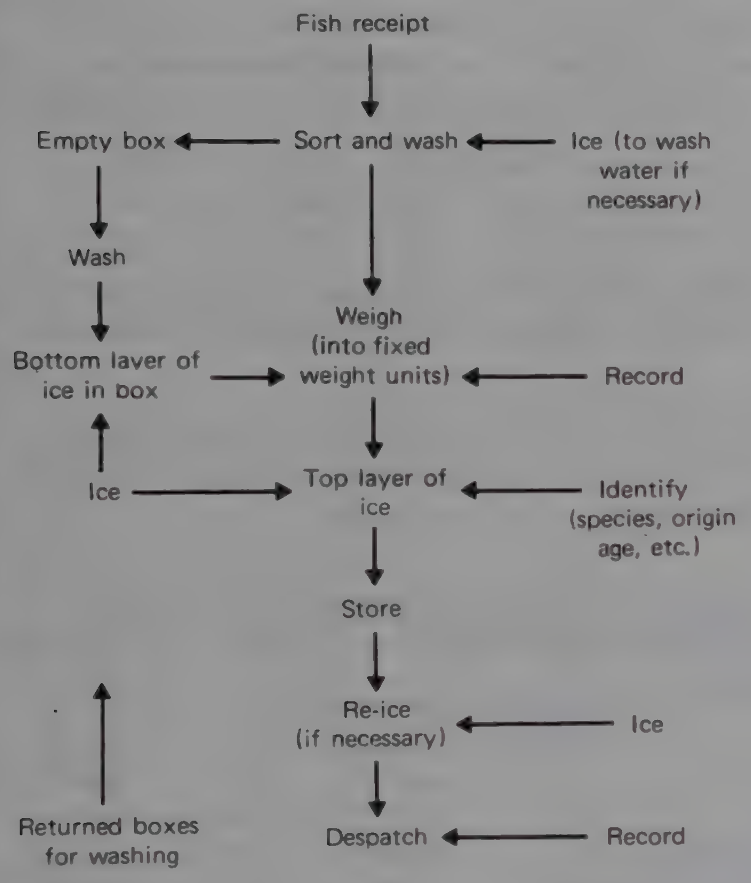

Fish receipt
Empty box
Sort and wash
Ice (to wash water if necessary)
Wash
Bottom layer of ice in box
Weigh (into fixed weight units)
Record
Ice
Top layer of ice
Identify (species, origin age, etc.)
Store
Re-ice (if necessary)
Ice
Returned boxes for washing
Despatch
Record

Table 1 gives theoretical costings for the operation of such depots and the supporting notes expand and explain these costings. The table shows 1, 5 and 10 ton daily throughputs and two input prices of 25 and 45¢/lb.

*Input fish costs:* It is impossible to standardize the cost of fish, ex-vessels, from country to country. Therefore, two basic fish purchase prices are used: 25 and 45¢/lb. These prices are specified as 'delivered-to-depot' costs for the purposes of the exercise. The purchase price of 25¢/lb was a reasonable, average, ex-vessel price for sea trout (*Cynoscion virescens;* approx 60% of fish trawled from the Guyana grounds) and is used in a UN Project Document (Millerd and Videaus, 1971) which is an investment report on the trawl fishing opportunity off the Guyana Coast. This price could apply to those countries in close proximity to these fishing grounds. The price of 45¢/lb was the current, average, delivered CIF price for sea trout, processed, frozen and packed in Trinidad and exported to various markets in the Windward/Leeward Islands. This price could be used as a basis in countries who would import from countries situated near the fish resources.

*Labour assessment:* The following assessments were based on UN Project experience in Curacao (Arrundale *et al.*, 1971), Trinidad (Arrundale, 1970a), Antigua (Arrundale, 1970b) and Barbados (Anderson, 1971) etc (Table 2).

Various modifications must be made to this labour assessment when they are applied to different countries eg differing wage rates, mechanized handling, building design and location etc (Table 3).

*Transport charges:* The assessment of transport costs (ie for despatch) will vary within the region. However, as a base, it is assumed that a 3-ton lorry could be hired for $150/day (actual Jamaica hire cost = $125/day travelling 200 miles/day) (Andersen *et al.*, 1971).

Considerable savings could possibly be made by purchasing vehicles and employing drivers, as was done in the UN project's Curacao Demonstration Landing Programme, where delivery charges were shown at 1.37¢/lb (2.8 ton/day) in an independent Government costing exercise (Arrundale *et al.*, 1971).

1 ton/day: It is assumed that because of this small throughput, transport charges would be minimal. However, a charge of 1¢/lb is included in the costing.
5 ton/day: 1 x 3 ton lorry at $150/day = $46,800/year = 1.67¢/lb.
10 ton/day: 2 x 3 ton lorries at $150/day = $93,600/year = 1.67¢/lb.

*Maintenance costs:* These would cover repair and maintenance of the chill rooms, ice plant etc. A charge of 5% of the plant and equipment capital is used.

TABLE 2. *Comparative labour costs at three different plant sizes*

| *Costs* | *1 ton/day 560,000 lb/year* | *5 ton/day 2,800,000 lb/year* | *10 ton/day 5,600,000 lb/year* |
|---|---|---|---|
| Labourers | | | |
| 'scaleman' | 1 | 1 | 2 |
| 'icing' | 1 | 2 | 4 |
| porters | 4 | 16 | 24 |
| Total (x $3,000) | 6 = $18,000 | 19 = $57,000 | 30 = $90,000 |
| Clerk/Storekeeper (x $3,840) | 1 = $3,840 | 1 = $3,840 | 2 = $7,680 |
| Foreman (x $4,800) | | 1 = $4,800 | 1 = $4,800 |
| *Total* | $21,840 | $64,640 | $102,480 |
| *Cost per lb* | 3.90¢ | 2.34¢ | 1.83¢ |

TABLE 3. *Some comparative wage rates (EC $ p.a.)*

| | *Labourers* | *Clerk/storekeeper* | *Foreman* | *Source* |
|---|---|---|---|---|
| Curacao | 5,000 | 8,000 | – | Arrundale *et al.*, 1971 |
| Barbados | 2,500 | 3,200 | – | Anderson, 1971 |
| Trinidad | 1,900 | – | 4,200 | Arrundale, 1970a |
| Jamaica | 1,800 | – | – | Anderson *et al.*, 1971 |
| Antigua | 1,500 | 2,000 | 3,500 | Arrundale, 1970b |
| *Standard used* | 2,500 | 3,200 | 4,000 | |
| Plus 20% social security, holiday pay etc | 500 | 640 | 800 | |
| *Total* | 3,000 | 3,840 | 4,800 | |

*Running expenses:* The running expenses of the basic facilities are virtually the electricity and water costs of the chill and ice plants. Large variations in these costs occur throughout the region. Examples of commercial costs of these services are given in Table 4 (Videaus, 1968–1971). For the purpose of this exercise, 1¢/lb of fish throughput is charged for the running expenses (excluding depreciation and maintenance) of chill stores and ice making machinery.

TABLE 4. *Ice and chill storage charges*

| *Region* | *Ice* ¢/lb | *Chill storage* ¢/lb |
|---|---|---|
| Barbados | 1.0 | 2.0 per month |
| | 2.0 | 2.5 ,, ,, |
| | | 1.0 ,, ,, |
| Grenada | 1.5 | 2.0 ,, ,, |
| St Lucia | 2.5 | 1.0 per week |
| Dominica | 2.5 | 1.0 ,, ,, |
| St Vincent | 2.0 | 0.5 per day |
| | | 2.0 per week |
| Trinidad | 1.1 | 2.5 per month |
| | 0.9 | |
| Montserrat | 2.44 | 1.0 per week |
| Antigua | 2.0 | – |

*Loss of fish:* Inevitably, and certainly during the initial stages of a fish marketing development programme, losses will occur when handling fish, a highly perishable commodity. Such losses will be caused, for example by quality deterioration, plant or vehicle breakdown, etc. Additionally, losses will occur when fish has to be sold at reduced prices due to exceptional marketing conditions eg during sudden glut situations; 5% of the purchase price of the fish is allowed in the costing. Good management and experience gained should substantially reduce the need for this allowance.

*Contingencies:* It is felt prudent to allow for a 10% contingency charge on prime costs, to cover rising prices, increased labour rates, unexpected installation difficulties etc.

*Management:* Although supervision is allowed for in the labour assessment, a charge of 1% of total prime costs is used to cover management, administration, selling costs etc. In many cases these management services could be handled by an already established marketing authority or commercial company.

*Plant and machinery depreciation:* Appendices 1, 2 and 3 give notes on plant and equipment, together with assessments and costs. Amortization over ten years is allowed for plant and machinery although, with proper care and maintenance, this equipment could have a longer working life.

*Building costs and depreciation:* The figure of $20 is used for the cost/ft$^2$ for building. Cost estimates obtained in Antigua = $19.50/ft$^2$ (Arrundale, 1970b).

1 ton/day depot (Figure 1) $20 × 1,600 ft$^2$ = $32,000
5 ton/day depot (Figure 2) $20 × 3,000 ft$^2$ = $60,000
10 ton/day depot (Figure 3) $20 × 5,100 ft$^2$ = $102,000

The life of the buildings is assessed at 20 years for depreciation purposes; this is a reasonable assumption.

*Bank charges:* These are calculated on a bank overdraft of the value of one month's fish purchases, at 8% interest per annum.

*Profit:* A 20% return on building and plant capital is used for the profit assessment, to arrive at the 'wholesale' price:

| | *1 ton/day depot* $ | *5 ton/day depot* $ | *10 ton/day depot* $ |
|---|---|---|---|
| Buildings | 32,000 | 60,000 | 102,000 |
| Plant and equipment | 26,700 | 54,120 | 92,000 |
| Total capital | 58,700 | 114,120 | 194,000 |
| 20% Return | 11,740 | 22,824 | 38,808 |

It is a matter of conjecture whether this is a realistic figure. A private company may think that net returns on cash outlays of 1.5 to 8% are not sufficient (see Table 5). On the other hand, a government-controlled wholesaling authority may feel a prime cost and on-cost recovery plus profits of between $19,000 and $102,000 is too much, when considering basic food prices etc, on sociological grounds.

An assessment of retail prices relating to the wholesale price and allowing an approximate 25% mark-up (20% on retail price) is given. This retail mark-up seems realistic (see sections on retailing and vendor earnings). Fish was bought for 45¢ and retailed at 75¢ in Barbados and this supports the 5 ton/day throughput calculation. Again, a government may wish to reduce this margin by subsidizing a government-controlled wholesale/retail organization.

TABLE 5. *Costs shown as percentage of wholesale and retail prices (Based on Table 1)*

| | | | | |
|---|---|---|---|---|
| *Buying price* | *25¢/lb* | | *45¢/lb* | |
| *Wholesale price* | *40¢ (39.01¢)/lb* | | *60¢ (59.59¢)/lb* | |
| *Retail price* | *50¢ (48.76¢)/lb* | | *75¢ (74.49¢)/lb* | |
| | *1 ton/day throughput* | | *5 ton/day throughput* | |
| | *% of retail price* | *% of wholesale price* | *% of retail price* | *% of wholesale price* |
| *Fish cost* | 50 | 62 | 60 | 75 |
| *Prime costs* | | | | |
| Labour | 8 | 10 | 3 | 4 |
| Transport | 2 | 2.5 | 2 | 2 |
| Maintenance | – | 1 | – | – |
| Running expenses | 2 | 2.5 | 1 | 2 |
| Fish losses | 3 | 3 | 3 | 4 |
| Contingencies | 6 | 8 | 8 | 9 |
| *Total prime costs:* | 21% | 27% | 17% | 21% |
| *On-costs* | 3 | 3 | 1.5 | 2 |
| Wholesale mark-up (net 'profit') | 6% | 8% | 1.5% | 2% |
| *Wholesale price* | 80% | 100% | 80% | 100% |
| Retail mark-up (gross 'profit') | 20% | | 20% | |
| *Retail price* | 100% | | 100% | |

TABLE 6. *Theoretical costing of a large retail unit (with sales of 2,240 lb/day ie 560,000 lb/250-day year)*

| *Item* | *Weekly (EC $)* | *Annual (EC $)* | *Cost/lb (¢)* |
|---|---|---|---|
| Fish purchases: 60¢/lb wholesale delivered | 6,720 | 336,000 | 60.00 |
| Staff: 1 @ $4,500 p.a., 3 @ $3,000 p.a. | 270 | 13,500 | 2.41 |
| Equipment: $12,000 @ 20% depreciation p.a. | 48 | 2,400 | 0.43 |
| Maintenance: 5% of $12,000 p.a. | 12 | 600 | 0.11 |
| Running expenses: electricity, water etc @ 1¢/lb | 112 | 5,600 | 1.00 |
| Sales expenses: wrapping paper, cleaning materials etc @ 1¢/lb | 112 | 5,600 | 1.00 |
| 5% Loss of fish: | 336 | 16,800 | 3.00 |
| Management and administration charge: $20,000 p.a. over 5 outlets | 80 | 4,000 | 0.71 |
| Advertising: | 100 | 5,000 | 0.90 |
| Bank charges: 1 week's fish @ 8% | 11 | 538 | 0.10 |
| *Total expenses* | 7,801 | 390,038 | 69.65 |
| Sales value @ 75¢/lb | 8,400 | 420,000 | 75.00 |
| *Net profit** | 599 | 29,962 | 5.35 |
| *Total profit from 5 outlets:* | | 149,810 | |

*% on expenses: 7.7%
% on capital: 250%

**The retail outlet**

Consideration of retailing is dealt with in three ways:

1. The use of large retail units selling one tonne of fish per day; five units being served by the wholesale depot handling five ton/day costed in Table 1.
2. A market hall, giving retailing facilities to ten self-employed 'vendors' built as an extension to the one ton/day depot costed in Table 1.
3. A chain of fishmongers' shops.

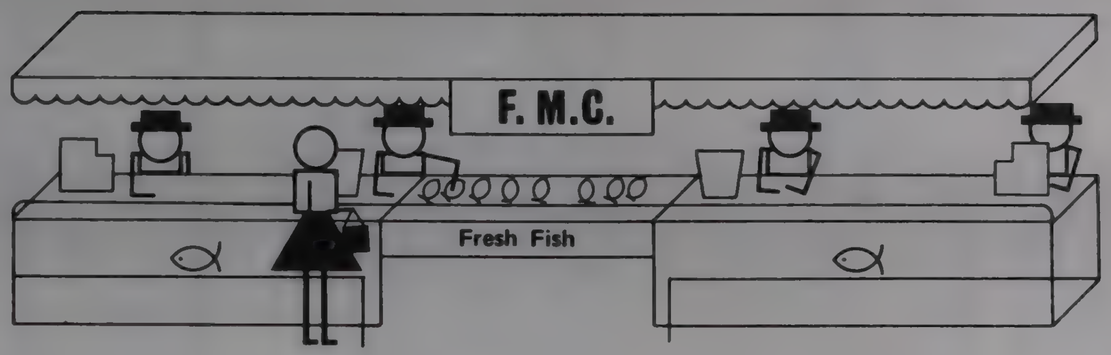
*Large retail selling units*

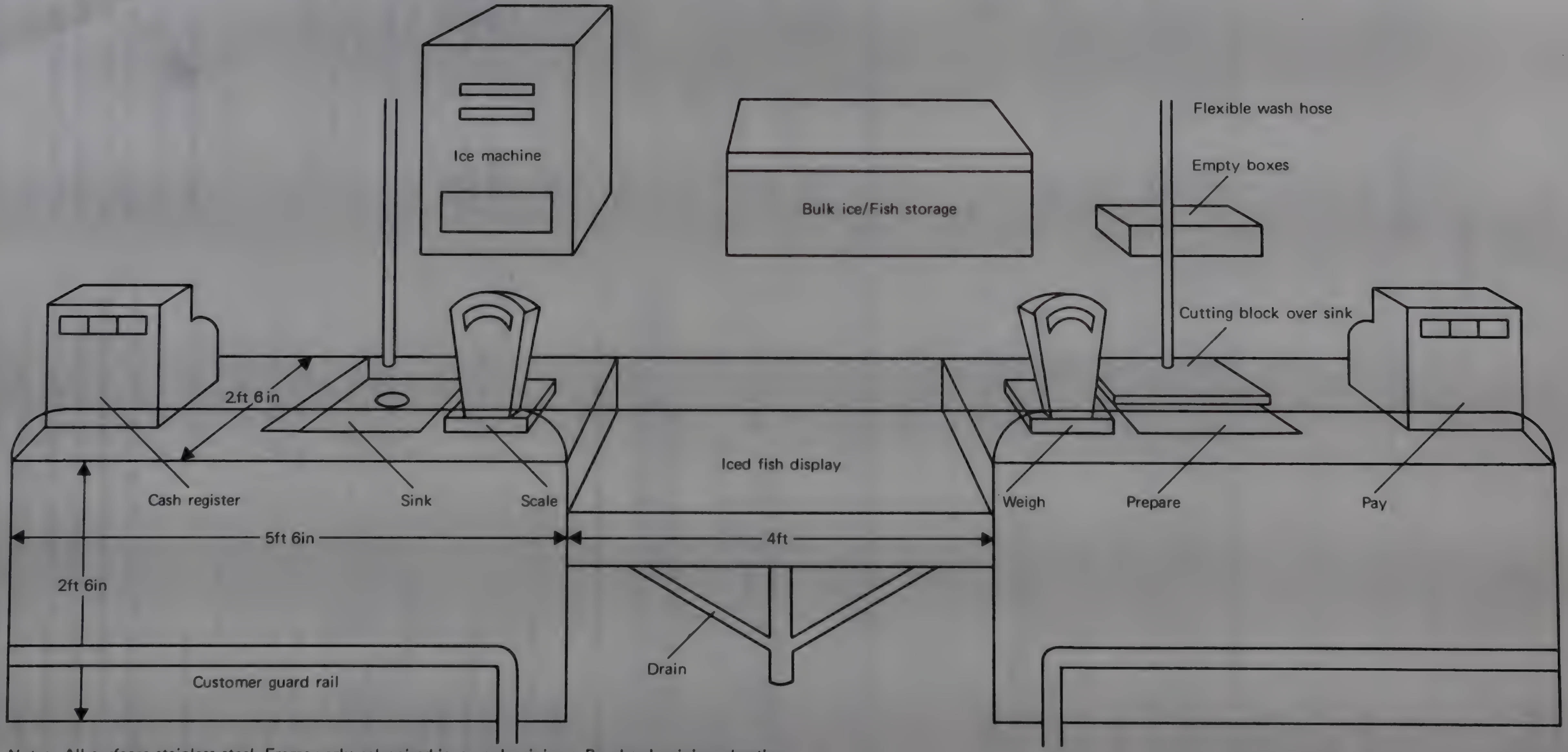
Table 6 considers the theoretical costing of a retail unit selling one ton of iced fish per day with a fish purchase price of 60¢/lb wholesale and a selling price of 75¢ retail. Supporting notes and comments enlarge upon this table and Figure 5 sketches one possible arrangement of such a unit.

*Fish purchases:* The purchase price assumes that the selling unit has its fish delivered from the '5 ton/day' wholesale depot considered in Table 1. A purchase

Figure 5
**Retail fish sales unit (1 ton per day)**

Total length 15ft


F. M.C.
Fresh Fish


Ice machine
Bulk ice/Fish storage
Flexible wash hose
Empty boxes
Cutting block over sink
2ft 6 in
Cash register
Sink
Scale
Iced fish display
Weigh
Prepare
Pay
5ft 6in
4ft
2ft 6in
Drain
Customer guard rail

Note: All surfaces stainless steel. Framework: galvanised iron or aluminium. Panels: aluminium sheeting price of 60¢/lb is used, although 59.59¢/lb is shown in the Table 1 projection, for calculation simplification. (From the rounding-up of this figure of 59.59¢/lb, the depot would derive an additional $11.480 'profit' if this retailing system was used.)

Actual project experience of selling in Barbados and in Curacao shows it is possible to sell one ton of fish from a retail unit such as the one described. Fish sales of 1,500 lb/3 sales girls/day have been easily attained and sustained in Barbados, and of 600 lb/1 salesman/day in Curacao (Arrundale *et al.*, 1971), with much less sophisticated equipment and facilities than are described in this report.

*Retailing staff:* One manager and three sales assistants have been assessed as being able to handle the volume of trade envisaged (as noted above). In actual practice, sales could be divided into two sellers 'selecting, preparing, wrapping' and two sellers 'receiving payment' (see Figure 5). The remuneration of $4,500 p.a. for the manager and $3,000 p.a. for the sales assistants could be part basic salary and part commission on sales.

*Equipment:* The equipment for this retail sales unit would be:

| | $ |
|---|---|
| Display and selling 'counter' | 3,000 (See Figure 5) |
| 5 ton/24 hours ice machine, complete with storage | 4,000 |
| Bulk storage (insulated chest) | 1,000 |
| Scales, cash registers, offal bins, cutting blocks etc | 3,000 |
| Miscellaneous: water connections, guide rails, awnings etc | 1,000 |
| | 12,000 |

These costs are deliberately placed high to ensure that equipment used would be of very good quality (stainless steel surfaces etc). No building costs are included, for it is assumed that this 'unit' would be placed in an existing market hall. A five year amortization period is allowed for (ie 20% depreciation per annum).

*Maintenance:* A charge of 5% of plant and equipment costs is allowed for maintenance.

*Running expenses:* These would include electricity and water. A charge of 1¢/lb is used.

*Sales expenses:* Cost of wrapping materials, cleaning aids etc should be covered by this charge of 1¢/lb.

*Loss of fish:* A 5% charge on the purchase price of the fish is allowed for loss of fish, deterioration of quality etc.

*Management:* A $20,000 p.a. charge for overall management administration etc, spread over the five retailing outlets, should be adequate.

*Advertising:* Project experience shows that advertising is essential in retailing fish in the Caribbean, especially during the preparatory and initial stages of a sales programme. The sum of $25,000 p.a. (ie 5 x $5,000 per sale outlet) should give an adequate publicity budget, especially if a large percentage of the money is used in the first two or three months of the operation.

*Bank charges:* As all the retail transactions would be in cash, bank charges on an overdraft covering one week's purchase of fish at 8% should be a satisfactory allowance.

*Profit:* A return of 7.7% of expenses or 250% return on capital is shown. As was stated earlier under the wholesaling operation, government sociological considerations or private enterprise policy may amend this profit.

*Combined wholesale/retail organization study:* If a marketing authority or a private company retails as well as wholesales, in the form expressed above, and if we take Barbados as an example, the total picture would show:

| | | | |
|---|---|---|---|
| Base: | Handling 5 ton/day through 1 wholesale depot and 5 retail outlets (1 ton/day each). (See Tables 1 and 6) | | |
| Price structure: | Purchase price 45¢/lb<br>Wholesale price 60¢/lb<br>Retail price 75¢/lb | | |
| Fish throughput: | 2,800,000 lb p.a. | Per capita consumption = *11.1 lb p.a.<br>Barbados population = 252,000 | |
| | Approx $8.33 at 75¢/lb retail p.a. | | $ |
| Capital: | 'Asset' capital: | Wholesale buildings | 60,000 |
| | | Wholesale equipment | 54,000 |
| | | Retail equipment x 5 | 60,000 |
| | | | 174,000 |
| | Working capital: | Wholesale | 105,000 |
| | | Retail | 3,000 |
| | | | 108,000 |
| | | | $ p.a. |
| Expenses contribution to an existing marketing organization (management and administration): | | | 36,000 |
| Direct employment: | 38 persons with a total salary income of | | 134,000 |
| Net profit: | Wholesale operation | | 34,000 |
| | Retail operation | | 150,000 |
| | | | 184,000 |

Return on 'asset' capital = 105.8%

---

*1967/68 per capita total fish consumption in Barbados (Videaus 1969) was 68 lb p.a. (whole round weight equivalent), of which 38 lb was imported.

The $184,000 'profit' represents 6.6¢/lb. This could be used, as a government subsidy, to reduce the retail price from 75¢/lb to approx 68.5¢/lb.

### *A fish market combined with a wholesale depot*

For the smaller islands, the concept of attaching a fish market to a wholesaling depot in which individual 'private' vendors operate may be appropriate. This basic unit could also be used in the larger countries where inland depots are needed. A suggested layout is sketched in Figure 6 and a draft 'Code of practice for fish vendors' is shown as Appendix 4.

**Figure 6**
**Fish market extension (1,280 ft$^2$)**

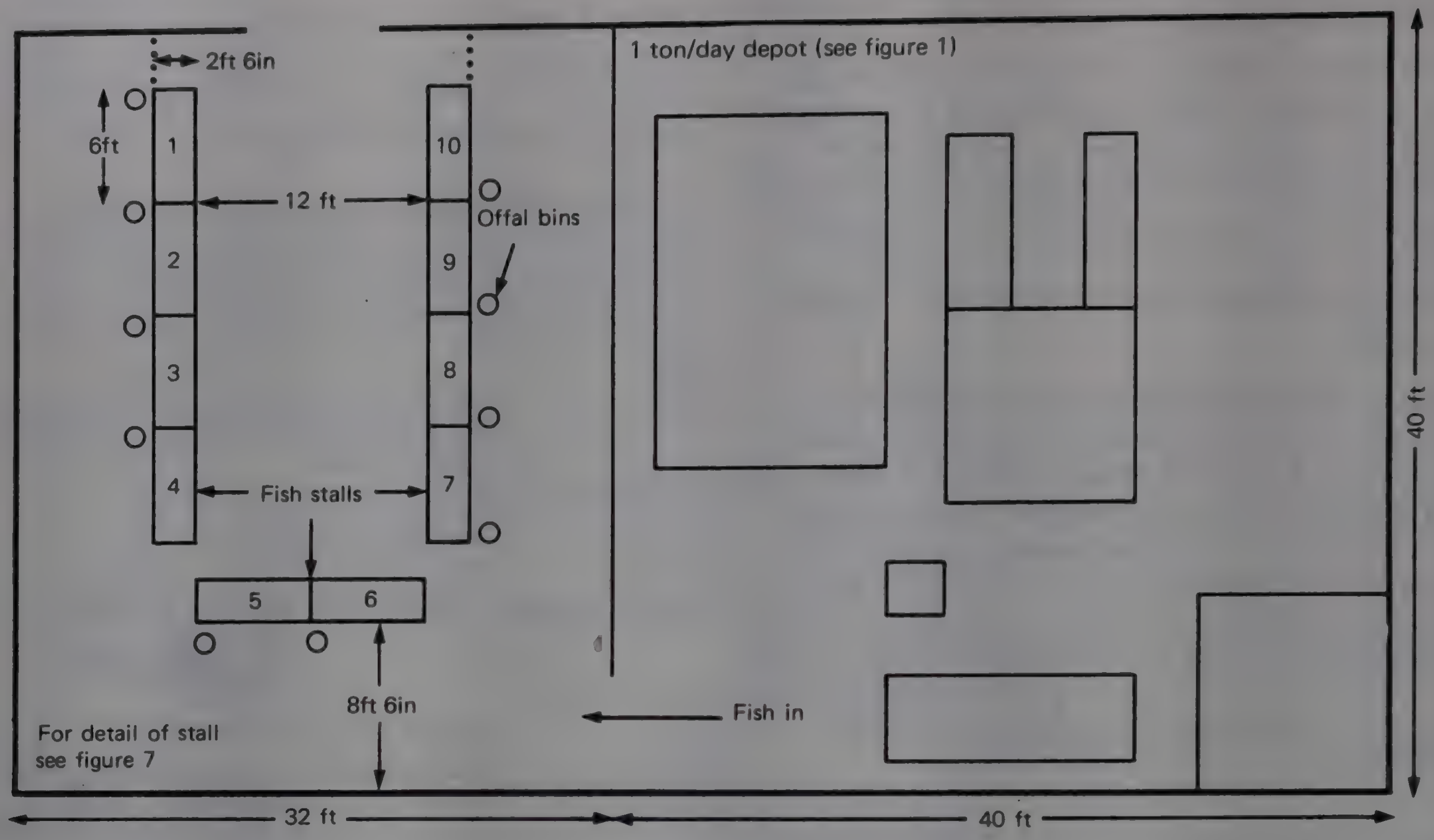

2ft 6in
6ft
1
2
3
4
10
9
8
7
12 ft
Offal bins
Fish stalls
5
6
8ft 6in
For detail of stall see figure 7
1 ton/day depot (see figure 1)
Fish in
40 ft
32 ft
40 ft

TABLE 7. *Theoretical costing of a wholesale depot extension/retail fish market (throughput: 1 ton/day)*

| *Item* | | *EC $* | *¢/lb* |
|---|---|---|---|
| *Expenses** | | | |
| Building extensions: 1,280 ft$^2$ @ \$20/ft$^2$<br>\$25,600 @ 5% depreciation p.a. | | 1,280 | 0.23 |
| Market equipment: \$8,000 at 20% depreciation | | 1,600 | 0.29 |
| Additional staff: 1 clerk/storekeeper<br>1 labourer | | 6,840 | 1.22 |
| Extra ice costs: 0.5¢/lb | | 2,800 | 0.50 |
| Running expenses: water, electricity, etc @ 0.25¢/lb | | 1,400 | 0.25 |
| Maintenance: 5% of building and equipment costs (\$33,600) | | 1,680 | 0.30 |
| | Sub-total | 15,600 | 2.79 |
| | Less 1¢/lb transport charges | 5,600 | 1.00 |
| *Total expenses* | | 10,000 | 1.79 |
| *Income* | | | |
| 'Wholesale cost' of fish: 39.01¢/lb (see Table 1) | | 218,450 | 39.01 |
| Selling to vendor: 40.00¢/lb | | 224,000 | 40.00 |
| Additional profit | | 5,550 | 0.99 |
| Market dues: \$2/day from 10 vendors for 250 days | | 5,000 | 0.89 |
| *Total income* | | 10,555 | 1.88 |
| | Less expenses (see above) | 10,000 | 1.79 |
| *Surplus* | | 555 | 0.09 |

*In addition to those of the wholesale depot (Table 1).

Using a basis of 1 ton/day, a buying price of 25¢/lb, a wholesale price of 40¢/lb and a retail price of 50¢/lb Table 7 shows a costing of this extension. The individual vendor's income is shown below:

| | | | |
|---|---|---|---|
| Sales | 2,240 lb (1 ton/day) | | |
| Sales/vendor | 224 lb (10 vendors) | | |
| Daily profit to vendor | $22.40 | buying at | 40¢ |
| | | retailing at | 50¢ |
| | | mark-up | 10¢ |
| Market dues | $2.00 | (0.89¢/lb)* | |
| Daily income | 20.40 | | |
| Vendor's weekly income | $102.00 | (5 days) | |

*Another, perhaps more suitable, way of generating a retail income would be to add 1¢/lb (as a service and ice supply charge) to the wholesale price.

*Buildings:* Figure 6 shows a floor plan for the extension of the '1 ton/day depot'. A square footage of 1,280 has been allowed and is costed at $20/ft² ($25,600) and depreciated at 5% p.a.

*Market equipment:* This would be:

| | $ |
|---|---|
| 10 'stalls' @ $500 | 5,000* |
| 10 scales @ $100 | 1,000 |
| 10 water connections, fittings @ $100 | 1,000 |
| Miscellaneous, offal bins, cutting blocks etc | 1,000 |
| | 8,000** |

*Quotations for much simpler stalls, with fibre glass covering or aluminium surfacing, show a cost of $100–$200 each; $500 has been taken for this, more elaborate, unit to allow for stainless steel construction, drainage, insulation etc (see Figure 7 for details).

**The figure of $8,000 is depreciated over 5 years.

*Staff:* An extra clerk/storekeeper and an extra labourer, in addition to the depot staff, have been budgeted for:

| | $ |
|---|---|
| 1 clerk/storekeeper | 3,840 p.a. |
| 1 labourer | 3,000 |
| | 6,840 p.a. |

*Ice costs:* An extra allowance of 0.5¢/lb has been given since it would be the 'market authorities' responsibility to provide ice (and insist upon its use) for the fish display and storage section of the stall (see Appendix 4 para 5).

*Running expenses:* These would be minimal due to the simplicity of the equipment used; 0.25¢/lb has been charged.

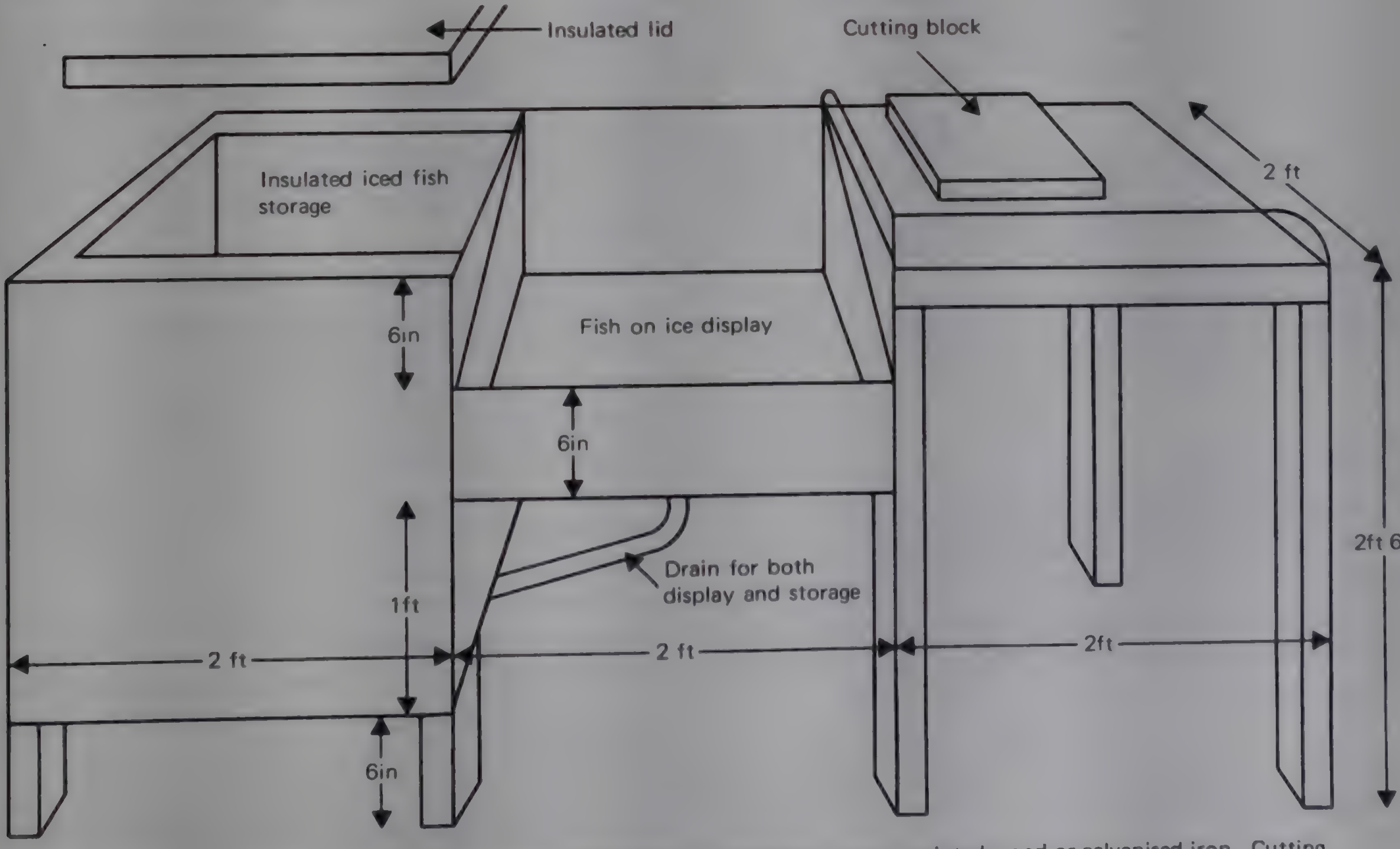
*Maintenance:* A 5% charge on capital costs of buildings and equipment has been made to cover maintenance costs.

*Transport:* In the costing for '1 ton/day wholesale depot', a 1¢ transport charge was included (see Table 1). This would not apply to this market hall extension concept and has therefore been deducted.

*Income:* The income of the market hall is derived from two sources: (a) the difference between the calculated wholesale cost, 39.01¢/lb, and the proposed charge of 40¢/lb to the vendor (Table 1); and (b) a market dues income of $2 per vendor/stall per day.

*Surplus:* The surplus or profit from the retailing section of the depot market unit is virtually nil. Again government policy, marketing agency consideration or private enterprise thinking could change this non-profit concept.

**Figure 7**
**Retail stall for 'Vendor' Fish Market**



Note: Overall dimensions 6ft x 2ft 6in. All surfaces stainless steel. Framework: epoxy painted wood or galvanised iron. Cutting block: compressed rubber

Not shown: water supply, scale, offal bin and cash box (drawer under serving table)

However, at 39.01¢/lb, the depot market complex would show a surplus of $12,000 per year on its wholesale operation (Table 1).

*Combined wholesale/retail study:* In a similar exercise to that done earlier (where Barbados was taken as an example), Dominica is used as an example to show the overall picture of a combined wholesale/retail organization. Since Dominica has, at the moment, a price structure (Videaus 1971a) which gives a current retail price of 75¢/lb, the effects of an amended price structure (45¢ buying, 64¢ wholesale and 75¢ retail price) on the figures are shown in brackets. Using the 45¢ buying price, Dominica could import fish now.

| | | | |
|---|---|---|---|
| Base: | A marketing authority wholesaling 1 ton of fish per day through a market hall (controlled by the authority) in which 10 independent vendors operate (Tables 1 and 7) | | |
| Price structure: | Buying price | 25¢/lb | (45¢/lb) |
| | Wholesale price | 40¢/lb | (64¢/lb) |
| | Retail price | 50¢/lb | (75¢/lb) |
| Fish throughput: | 560,000 lb p.a. | | |
| | Per capita consumption* = 8.1 lb p.a. | | |
| | Dominica population = 69,000 | | |
| Capital: | 'Asset' capital: | $ | |
| | Wholesale | | |
| | buildings | 32,000 | |
| | equipment | 26,000 | |
| | Retail | | |
| | buildings | 26,000 | |
| | equipment | 8,000 | |
| | | 92,000 | (92,000) |
| | Working capital | 12,000 | (21,000) |
| | | $ p.a. | $ p.a. |
| Expenses contribution to an existing marketing organisation (management and administration): | | 2,000 | (3,000) |
| Direct employment: | 9 persons with a total salary income of | 29,000 | (29,000) |
| Indirect employment: | 10 vendors with a total income of | 51,000 | (56,000) |
| Net profit: | Wholesale operation | 11,740 | (11,740) |
| | Retail operation | 555 | (3,512) |
| | | 12,295** | 15,252** |

Return on 'asset' capital = 13.4% (16.6%)

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*1969 per capita total fish consumption in Dominica (Videaus, 1971a) was 72.4 lb p.a. (whole round weight equivalent) of which 50.7 lb was imported.

**The $12.295 ($15,252) profit represents 2.19¢ (2.72¢)/lb on the retail price. This could be used as a Government subsidy to reduce the retail price to approx 48¢ (72¢)/lb.

### *The fishmonger's shop*

In the more developed Caribbean countries, there is a need for more sophisticated retailing. The following gives details of a fish shop which could fit into Caribbean conditions. The work in this section of the paper is based on Curacao in 1970; the costings are in Netherlands Antillian Guilders.

*Shop layout and design:* The basic concept of the fish shop is to sell mainly fresh fish in a modern and hygienic manner. The most important selling unit is a refrigerated cabinet running at one or two degrees above freezing point. In this cabinet fresh fish is displayed on ice. The rest of the equipment in the layout (Figure 8) is designed to support and complement this main effort.

The layout is designed to give the customer a large display area from which to choose the fish. The sales force will take the customers' selection of fish and prepare it by cleaning, heading, steaking, scaling, filleting etc according to the instructions of the buyer. When prepared, the fish will be wrapped and placed into a polythene covering which will not leak fish juices.

The display itself will show as large a selection of fish as possible. It will be made more appealing and attractive by the use of colour, eg fresh parsley, tomatoes, limes etc. The other items sold will complement the consumer purchases by impulse sales and should therefore be attractively and persuasively displayed.

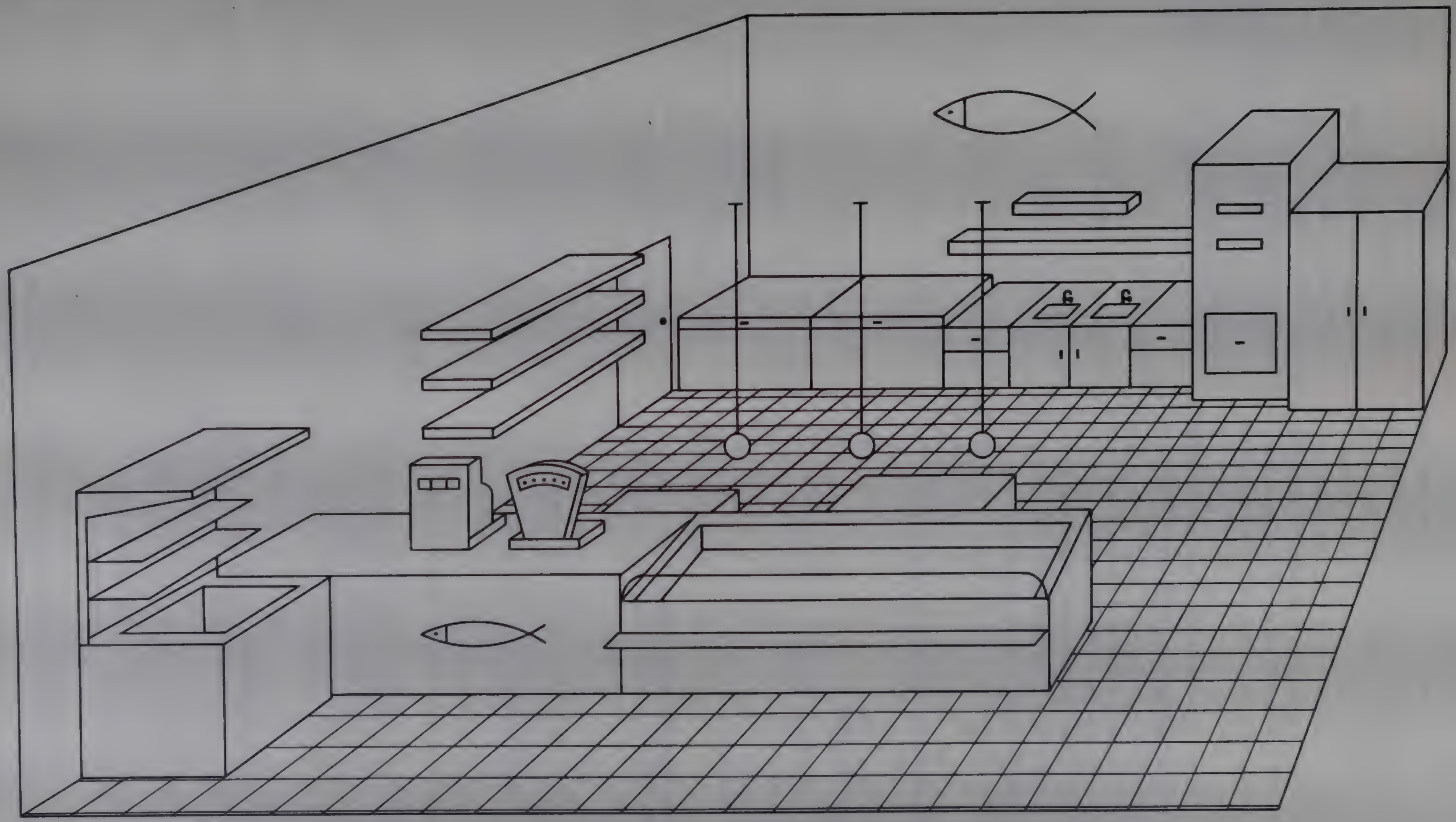
The keynote of the shop will be to give an impression of a cool, hygienic and fresh atmosphere. There will be no fish smell and great care will be taken to remove offal and other preparation by-products quickly. The two sections of the shop, dry for the customers and washable for the serving area, will enhance this impression of cleanliness and efficiency. White protective clothing will be worn by the staff and great attention will be paid to personal appearance and cleanliness.

The layout does not show the ancillary service areas required: iced fish receipt area, dry goods store, staff toilet and cloak room facilities, offal bins etc.

*Equipment and fittings:* A description of the equipment and fittings shown on the layout (Figure 8) is as follows:

1. Fresh fish display: This is a six metre cabinet running at one or two degrees above freezing point. It will be made of washable material and the parts in contact with the fish will be made of stainless steel. It will have a drain plumbed into the shop's drainage system. Approximately 150 kg of fish will be displayed and frequent replenishments from the bulk storage will be made.
2. Dry display counter: This will be a formica or stainless steel topped bench upon which will be displayed the range of dry goods offered to complement fresh fish sales. Wall shelving will augment this display. Part of this counter will be used for shop scales and a cash register.
3. Preparation, wrapping and washing areas: All dirty preparation (gutting, scaling, filleting etc) will be carried out at the blocks adjacent to the stainless steel sinks. Constant, cold running water will be used and a supply of hot water and a bactericidal detergent will be available for cleaning blocks, knives etc. Simple preparation, heading or steaking, will be carried out on the preparation block adjacent to the display. The fish will be wrapped after it has been weighed. The preparation and wrapping units will be covered with stainless steel or formica and the preparation areas adjacent to the sinks will have a compressed rubber cutting block and a hole in the working surface which will connect with the refuse bins.
4. Deep freeze cabinet: This will be a large hotel type of deep freeze locker. Bulk packs of speciality products will be stored here. Fresh products or defrosted products will not be frozen or refrozen in this cabinet. The operating temperature will be – 25°C.

Figure 8
Layout and design of fishmonger's shop



5. Fresh fish storage: This will be an insulated, lidded container (approximately 5 m x 1 m) which will hold up to 500 kg of well-iced fish, either in boxes or loosely packed. It will have a drain connected to the main shop drainage system. It will be cleared and cleaned thoroughly, at least every two days.
6. Flake ice machine and ice storage: An ice making machine, capable of producing 0.5 tons of flake or tube ice will be installed over an insulated ice holding chest. The chest will be capable of holding at least 250 kg of ice and will be drained into the shop drainage system.
7. Zero display cabinet: This will be a standard refrigerated cabinet holding retail branded packs of fish and fish products.
8. General: The walls will be tiled if possible, the floors will be of terrazo tiles or similar non-porous material. The shop will be air-conditioned. The colour scheme of the shop should be light and bright. Decorative pot plants and possibly an aquarium could be featured.

*Estimate of costs:* An estimate of costs of the equipment and fittings based on Curacao prices is as follows:

| | | f |
|---|---|---|
| 18 ft chill display cabinet | | 4.200 |
| Deep freeze (hotel type) | | 5.000 |
| Zero cabinet | | 4.000 |
| Ice machine (North Star) 0.5 ton/day | | 3.000 |
| Iced fish storage | | 2.000 |
| Ice storage | | 1.000 |
| | | 19.200 |
| | say | 20.000 |
| Fittings, counters, shelves, air conditioning, refuse bins, boxes etc | | 10.000 |
| | | 30.000 |

*Range of products:* The basic sales of the shop would be based on a supply of marine continental shelf fish (sea trout, croaker and whiting); this being the only source of supply large enough to satisfy a chain of shops. This range would be augmented by:

(a) Locally caught fish: snapper, kingfish, dolphin, shellfish etc.

(b) Salt cod and pickled fish: to cover the local taste for dried salt cod fillets this would be offered for sale. Imported herring in barrels and similar products could be sold.

(c) Canned and bottled fish products: canned salmon, tuna, sardines etc would be offered for sale. Semi-preserves could be handled by using the chill section of the zero cabinet.

(d) Miscellaneous: non-fish products complementary to fish would be offered for sale eg seasonings, sauces, pickles, packeted breadcrumbs, cooking oil, fresh limes and lemons, etc.

*Price structure:* Tentative wholesale and retail prices are given below (f/kg).

| | |
|---|---|
| Average wholesale price (round fish delivered) | 0.80 |
| Retail mark-up | 0.50 |
| Average retail selling price | 1.30 |

Typical retail prices to be charged in the shop:

| | |
|---|---|
| Dressed sea trout on bone | 1.60 |
| Sea trout steaks | 2.00 |
| Croaker on the bone | 1.30 |
| Whiting whole fish | 1.10 |
| Whiting fillets | 2.50 |

Existing prices (f/kg) in Curacao for whole undressed uniced fish sold from the present fish markets are: sea trout, 1.60; croaker, 1.30; mixed, 1.10.

*Break-even point:* These calculations are based on Curacao. However, adaptations for the other Caribbean countries, in terms of price structure, rent, staff etc, could produce a break-even point for that particular area.

| | | f/week |
|---|---|---|
| Rent: for 1,000 ft$^2$<br>f 5,000 p.a. | say | 100 |
| Equipment: f 30,000 over 5 years<br>f 6,000 p.a. | say | 120 |
| Staff: 1 manager | | 150 |
| 2 assistants (female) | | 100 |
| 1 cashier | | 60 |
| Overheads: power, water, maintenance etc. | | 100 |
| Stocks (interest): f 1,500/week @ 10% p.a. x 5 weeks | | 15 |
| Banking costs: say 10% interest on f 7,000 | | 14 |
| Advertising and promotion costs: | say | 31 |
| Insurance costs: | | 10 |
| | | 700 |

At 50 ¢/kg mark-up, the break-even point is 1,400 kg/week or 234 kg/day.

Notes on above calculations follow:

1. The salary of the Manager is placed at a fairly high level. It is anticipated that the salary would be partly fixed and partly commission. The female assistants are paid at f 50 per week and could also be paid on a sales commission basis. The cashier is paid at an extra f 10 per week for the additional responsibility.
2. The f 100 per week for overheads is a pure estimate but should cover these costs adequately.
3. The high stock cost of 10% over five weeks is intended to cover spoilage and deterioration as well as capital costs; f 1,500 x five weeks is equal to a stock cost of over 9,000 kg of fish at 80¢ wholesale, an adequate cover.
4. Banking costs are intended to cover an overdraft of f 7,000 for working capital. This is probably over the required figure. No interest charge is made on the assets of the shop in equipment and fittings. It is assumed that this cost will be borne by share capital and that the five year depreciation charge will cover replacement needs of the assets.
5. Additional advertising and promotion costs would be taken out of profits. The f 31 per week is a nominal sum for point of sale material. A fairly heavy expenditure on promotion is envisaged.
6. An insurance premium of f 500 per year should adequately cover this item.

*Turnover and profitability:* As is seen in the foregoing calculation, a break-even point is reached at 234 kg/day with an average 50¢/kg mark-up. It would seem reasonable to expect to retail 350 kg of fish per day. This would give 2,300 kg/week and, at an average cost of f 1.30, would give a weekly turnover of f 2,730. At a 50¢ mark-up the gross profit would be f 1,050 per week.

Weekly expenses of f 700 (see break even calculation) would give a net profit of f 350 per week (f 19,200 per year) return on a capital outlay of $30,000 (64%).

*Operational procedure*

Receipt of fish: there would have to be an early delivery of the day's requirement by insulated lorry from the wholesaler. The fish would be delivered in boxes with ice and would immediately be transferred to the fresh fish storage unit. Weekly deliveries of frozen fish for the retail cabinet and the deep freeze would be expected. Deliveries of dry goods would be as and when convenient. Additional purchases of fish from local fishermen would be made on a daily basis. It should be emphasized that only the fresher of fish would be accepted from this local source.

Disposal of offal: frequent removal of offal from the shop to tight-lidded containers in a shaded outside area is essential. Daily removal of these bulk offal containers is also important. After each emptying of both the 'shop containers' and the main offal bins, thorough cleansing and disinfecting would be carried out.

Selling: after selecting, preparing, weighing and wrapping, the customer's purchase would be paid for at the cash register. Only the cashier would handle money.

Display: each morning the display will be made from the storage unit. The display will be augmented frequently during the day to ensure that the cabinet is always full and complete in range. At the close of business, fish will be removed from the display cabinet and stored, well iced, in the storage unit. The cabinet will then be thoroughly washed with a disinfectant and bactericidal agent.

Records: accurate records of fish receipts, sales stocks etc must be maintained. The cashier will be responsible for keeping cash records.

*Shop location:* It is felt that because this type of shop will; initially, appeal to the middle and upper income groups, it should be located where car parking facilities are available. The ideal location for this type of shop seems to be adjacent to a supermarket or an established shopping centre.

## Conclusions

Realistic governmental development plans throughout the region show a potential fleet investment in the south, in trawl fishing, of 150 fishing trawlers within a 10 year period and considerable snapper fishing vessel investments in the north.

A substantial export trade is now developing, or is being planned, to supply frozen fish (for sale as 'fresh') trawled by those countries geographically situated in a position to exploit the known resources.

It is also hoped that some of the concepts and ideas in this paper could be useful to other developing countries.

## References

**Anderson** (1971) An outline fish marketing programme for Barbados. FAO Project Document (Unpublished).

**Anderson, Christensen, G.** *et al.* (1971) A report on fish marketing development in Jamaica. FAO Project Document. SF/CAR/REG 189 – M26.

**Arrundale, J. F.** (1970a) Trawl fish processing and marketing in Trinidad. FAO Project Document (Unpublished).

**Arrundale, J. F.** (1970b) A fish marketing scheme for Antigua. FAO Project Document. SF/CAR/REG 189 – M16.

**Arrundale, J. F.** (1971) Guidelines for development of fish wholesaling and retailing in the Caribbean. FAO *ad hoc* Project Paper.

**Arrundale, J. F. & Girigorie** (1970) The fishmongers' shop in the Caribbean. FAO Project Document. SF/CAR/REG 189 – M25.

**Arrundale, J. F., Vidaeus, L. O. & Girigorie** (1971) Fish marketing demonstration charter vessel programme, Curacao. FAO Project Document. SF/CAR/REG. M20.

**Millerd & Vidaeus, L. O.** (1971) Fish – food and investment. FAO Project Document. SF/CAR/REG 16 – M1.

**Rathjen, Yesaki & Hsu** (1968) Trawl fishing potential off north eastern South America. FAO Project Document.

**Vidaeus, L. O.** (1968–1971) Inventories of countries – fishing industries. FAO Project Documents.

**Vidaeus, L. O.** (1969) An inventory of the Barbados Fishing Industry. FAO Project Document.

**Vidaeus, L. O.** (1971a) An inventory of the Dominica Fishing Industry. FAO Project Document. SF/CAR/REG 189 – M18.

**Vidaeus, L. O.** (1971b) A summary report on a series of country studies. FAO Project Document. SF/CAR/REG 189 – M24.

## APPENDIX 1

**Basic plant and machinery for wholesale depots** (Ref. Appendix 2)

| *1 ton/day* <br> *0.56 x $10^6$ lb* | | *5 ton/day* <br> *2.8 x $10^6$ lb** | | *10 ton/day* <br> *5.6 x $10^6$ lb* | |
|---|---|---|---|---|---|
| | *EC $* | | *EC $* | | *EC $* |
| 1 x 10 ton chill | 8,000 | 2 x 10 ton chills | 16,000 | 3 x 10 ton chills | 24,000 |
| 1 x 1.5 ton ice machine | 9,000 | 1 x 3 ton ice machine | 16,000 | 2 x 3 ton ice machine | 32,000 |
| 1 x 5 ton ice store | 1,000 | 1 x 10 ton ice store | 1,600 | 2 x 10 ton ice store | 3,200 |
| 250 boxes | 1,750 | 1,000 boxes | 7,000 | 1,500 boxes | 10,500 |
| 1 scale | 1,500 | 1 scale | 1,500 | 2 scales | 3,000 |
| Miscellaneous | 2,000 | Miscellaneous | 3,000 | Miscellaneous | 4,000 |
| | 22,250 | | 45,100 | | 76,700 |
| 20% Installation | 4,450 | 20% Installation | 9,020 | 20% Installation | 15,340 |
| Total assessed | 26,700 | Total assessed | 54,120 | Total assessed | 92,040 |
| 10% Depreciation (p.a.) | 2,670 | | 5,412 | | 9,204 |
| Cost/lb | 0.48¢ | | 0.19¢ | | 0.16¢ |

*Based on actual delivered costs – Curacao. Arrundale *et al.*, 1971.

## APPENDIX 2

**Actual plant and equipment costs for fishmongers shop (based on purchases for Curacao and all prices delivered Curacao)**

| | |
|---|---|
| 10 ton sectional chill room, 1,407 $ft^3$, complete with compressors and evaporator coils | EC $ 7,699.77 |
| 3 ton flake ice machine/24 hours complete with compressors etc | EC $ 15,805.34 |
| Platform scale, 227 kg x 0.25 kg divisions with taring device | EC $ 1,428.00 |
| Plastic fish boxes, 800 x 450 x 265 mm 60 litre capacity | EC $ 6.99 |
| Support and ice storage bin (10 ton), locally made, insulated | EC $ 1,600.00 |

## APPENDIX 3

**Notes on basic plant and equipment**

**Chill accommodation**

Prefabricated, walk-in chill rooms are suitable. These can be ordered as packaged units, ie complete with their own refrigeration plant (compressors, condensers etc).

The chill room should be maintained at a temperature of 0–2°C. It is essential that fish stored in chill rooms should be well iced and that the temperature of the chill room allows the ice to slowly melt. Melting ice is the fundamental cooling agent, not the chill room. The chill room's function is to prevent the ice melting too quickly. If necessary, boxes of fish in chill rooms must be 'topped up' with ice during storage.

*Specification*

For 10-ton capacity, a 1,400 $ft^3$ (approx 11.5 x 18 x 8.5 ft OD) chill room will give sufficient space for stacking the boxed, iced fish and for gangways for easy access.

The chill room and its ancillary equipment should be able to maintain a temperature of 0°C against an ambient temperature of 38°C maximum with water available at 30°C maximum.

Wall and ceiling insulation should be 4 inch thick polyurethane (or other material of similar characteristics). Floor insulation should be 6 inch thick compressed cork (or other material of similar characteristics). The door should be insulated as for the wall and be at least 6.5 ft high and 2.5 ft wide (clear opening).

Bulkhead light fittings should be provided inside the chill room and the internal walls of the chill room should be protected by strips of 3 x 2 inch wood to a height of 3.5 ft.

Refrigeration equipment (ie compressor plant and ceiling mounted evaporators etc) should be an integral part of the chill room unit and be controlled thermostatically and automatically.

All necessary piping, first refrigerant charge, electrical starters and fittings for the refrigeration equipment would normally be included in the 'unit' cost; wiring, foundations and erection costs would be excluded.

*Note:* In certain situations, it may be convenient to have one or more of the chill rooms designed as a combination chill room/temporary cold store. This could be particularly useful where a depot is handling frozen fish (for subsequent sale as 'fresh') and delivery is relatively infrequent. Suitable specification amendments should be made to the request for quotations and the manufacturer's advice obtained.

It must be emphasized that a prefabricated chill room could only be used as a cold store for short-term storage of frozen fish, because sub-zero temperatures could not be maintained. It should be further emphasized that defrosted fish should never be re-frozen and that fresh fish should not be placed in a cold room running at below freezing point. Defrosted frozen fish should be treated as fresh fish and kept well iced at all times.

### Ice machines

Ice is essential in a fish handling depot and at retail outlets. It is needed to keep fresh fish at the correct temperature (ie as cold as possible without freezing) during storage, distribution and selling. The most suitable types of ice machines are those producing flake or tube ice. This type of ice is small, mixes intimately with the fish and does not damage or bruise the flesh of the fish.

*Specification*

Several 'packaged unit' ice making plants are on the market. When ordering the type of your choice it is sufficient to specify only the output required per 24 hours with condenser water temperature at a maximum of 29°C.

It is important to have adequate water supplies for this machinery. For example, one type of machine requires 3.5 gallons per minute for a 1.5 ton output; 15 gallons per minute for a 3 ton output.

### Ice holding stores

Since ice making machines produce ice on a continuous basis and are usually worked over 24 hour periods, it is essential to have a holding capacity. Normally, ice holding stores are not refrigerated but are well insulated. Depending on circumstances (eg frequency of fish delivery or despatches), the capacity of the storage required can be worked out.

*Specification*

These stores can usually be made locally; 4 inch polyurethane (or similar material) insulation is sufficient. It is often convenient to form an ice holding store by enclosing, with suitably insulated panels, the supporting frame required for overhead ice machines.

### Scales

The best type of scale for depot operation is a platform type with direct clock reading. A useful refinement is to have a tare device which can be set to compensate for weight of the fish box and bottom layer of ice.

*Specification*

A suitable scale would be a self indicating fish dock scale; capacity 400 lb, chart graduated 0–300 lb in 1 lb divisions, fitted with a rapid tare device (range 100 lb), a galvanized platform 24 x 24 in and a galvanized back rail 18 in high.

### Fish boxes

Plastic fish boxes have been found to be the most suitable for storing, transporting and distributing iced fish. The type which nests and stacks is best in terms of efficient use of storage space. The boxes must have drainage holes to allow the melt-water to run away.

*Specification*

Capacity 60 litres (approx 60–70 lb of fish with ice), external measurements 800 x 450 x 265 mm (approx 32 x 18 x 10.5 in high).

## APPENDIX 4

### Fish marketing authority

### Code of practice for fish vendors

Fish is a highly perishable product which must be offered to the public in the freshest and most hygienic condition possible.

The following are rules which must be observed by all fish vendors in the ................................................ Fish Market. Failure to comply with these regulations will result in fish vendor licences being revoked or not renewed.

1. Fish vendors must be clean and tidy in their dress and person.
2. The vendor must not be suffering from any notifiable disease and must not be suffering from any skin infection. Minor cuts on the hands must be protected by a waterproof dressing which must be kept clean and frequently changed. Fingernails must be kept clean and short.
3. No smoking or spitting will be allowed in the retail hall.
4. After use of the toilet facilities, hands must be thoroughly washed in the wash hand-basins provided.
5. No fish will be displayed unless placed upon a layer of ice with ice intimately mixed through. No fish will be stored unless it is well iced.
6. Stagnant water in buckets, pails and other containers will not be allowed to be used to wash fish, hands or utensils. The fresh running water supplies to the stalls will be used to clean knives, hands, utensils etc.
7. Offal (skin, bones, guts etc) will be placed in the lidded bins provided as soon as it is produced.
8. The stall and its surroundings will be kept clean and tidy during the day's trading.
9. Any fish remaining in the vendor's possession at the end of the day's trading must not be offered for sale the next day unless it has been adequately boxed, iced and stored in the Authority's chill room.
10. Bad language or unruly behaviour will not be permitted.

By order of the Management

........................Fish Marketing Authority

# The fresh fish trade in Indonesia

**S. Ilyas**
Research Institute for Fishery Technology, Indonesia

### Summary

The geography of Indonesia makes the country well suited to both marine and freshwater fish production and the total catch exceeds 5 million tons. Half of the catch is processed by traditional methods and the remainder is sold fresh. Frozen fish constitutes only 3 per cent of the total but this represents a valuable and expanding export trade in shrimp, tuna and frogs legs.

The paper outlines the current patterns of fish utilization and considers the problems which hinder any improvement in fish distribution and marketing. The great distances between the areas of production and the consumer centres is a major constraint as is the uneven population density. Technological, socio-economic and administrative problems, and the interplay between them, are discussed in relation to fisheries development. The paper concludes with a number of suggestions for overcoming these difficulties and points the way to an improved system of fish distribution and marketing in Indonesia.

### Résumé

La géographie de l'Indonésie rend ce pays bien adapté à la production de poissons de mer et de poissons d'eau douce, le montant total des pêches dépassant 5 millions de tonnes. La moitié de celles-ci est traitée selon les méthodes traditionnelles et le reste est vendu à l'état frais. Le poisson congelé ne constitue que 3 pour cent de la production totale, mais cela représente un commerce d'exportation de valeur et en expansion, dans le domaine des crevettes, du tuna et des cuisses de grenouilles.

Ce mémoire esquisse les types actuels de l'utilisation du poison et considère les problèmes qui entravent toute amélioration de la distribution et de la vente du poisson. Les grandes distances entre les zones de production et les centres de consommation sont une gêne majeure, ainsi que la densité de population inégale. Les problèmes technologiques, socio-économiques et administratifs, ainsi que leurs effets réciproques, sont discutés en relation avec le développement de la pêche. Ce mémoire se termine par plusieurs suggestions pour surmonter ces difficultés et montre la voie vers un système amélioré de distribution et de vente du poisson en Indonésie.

### Resumen

Indonesia, por su geografía, es un país apropiado para la producción pesquera, tanto marina como de agua dulce, y el total de las capturas es superior a 5 millones de toneladas. La mitad de las capturas se elabora por métodos tradicionales y el resto se vende fresco. El pescado congelado sólo constituye el 3 por ciento del total, pero ésto representa un importante y creciente comercio de exportación de gambas, atún y ancas de rana.

El artículo describe las modalidades actuales de utilización de pescado, y considera los problemas que entorpecen cualquier tipo de mejora en la distribución comercialización del pescado. Las grandes distancias entre las áreas de producción y los centros de consumo constituyen el principal inconveniente, junto con la falta de uniformidad en la densidad de población. Se discuten los problemas technológicos, socio-económicos y administrativos, así como las interconexiones entre ellos, en relación con el desarrollo de pesquerías. El artículo concluye con algunas sugerencias para superar estas dificultades, y señala la posibilidad de un sistema mejor de distribución y comercialización del pescado en Indonesia.

## Introduction

Geographically, the Indonesian Archipelago is ideally suited to fish production due to its wealth of marine as well as inland waters and to its wet type of rice farming. However, in terms of fresh fish distribution these same conditions present a serious handicap, chiefly due to the great distances separating fish producing areas from consuming centres.

Besides meeting the protein need of the people, the main purpose of Indonesian fish utilization is to provide employment opportunities, to improve the relatively low income of fishermen and also to derive more foreign exchange for further fishery development.

Some factors which adversely affect fresh fish distribution and utilization of the catch generally are:

- the wide geographical distribution of the thousands of islands,
- the warm and humid tropical climate,
- the uneven population distribution,
- the tropical character of the resource and the great variety of fish species involved,
- the lack of capital, knowledge and skill, and
- the low buying capacity of the majority of the people.

During the first Five Year Development Plan (1969–1974) efforts were made to create favourable conditions for stimulating new capital for the fishery industry and in improving fishery management capabilities. This resulted in the tremendous increase of exports in terms of volume and value and better utilization for domestic consumption. It also resulted in competition, for the fresh raw material, between the export processing industry and local fresh fish distributors.

Within the second Development Plan (1974–1979) more stress is being given to improving the artisanal fishery, by providing facilities for landing, culture, handling and processing, and expanding fresh fish distribution.

## Production and utilization

### *Production potential*

Most of the Indonesian territory consists of marine waters, which cover an area four times as large as the land surface. In addition, vast areas of fresh water are found throughout the 13,667 islands belonging to the country.

The total potential of 5,256,000 tons of fish consists of 1,380,000 tons of pelagic fish, 2,466,000 tons of demersal fish and 1,410,000 tons of freshwater (inland) fish. Only one quarter of the estimated total has been exploited to date.

In contrast to the subtropical marine fauna, tropical fisheries are characterized by fish of a smaller size and a much greater range of species. These factors raise considerable problems in handling on board, unloading and processing.

The bulk of the catch consists of pelagic as well as bottom fish from coastal waters, mainly clupeids, carangids and scombroids. There is a big potential for skipjack tuna in Indonesian waters especially in the Indian Ocean and the Banda Sea. Recently, skipjack and other big tuna (bluefin and yellowfin tuna) are being exported by joint venture fishing companies and state-owned fishing enterprises.

Export of frozen shrimp has played an important role in the development of the Indonesian fishery since 1968. Shrimp resources, stretching from the Malaka Strait to the Arafuru Sea (the Arafuru Sea is considered one of the best new shrimp grounds), have been intensively exploited by artisanal fisherman as well as modern trawlers. From an estimated potential of 216,000 tons of shrimp (134,000 tons of marine shrimp and 82,000 tons of brackish-water shrimp) only 33, 244 tons were exported in 1974 (see Table 1). Besides marine shrimp, the giant freshwater shrimp (*Macrobrachium rosenbergii*) is now exported; efforts have been made to grow them on a commercial scale.

TABLE 1. *Export of shrimp and total fishery products from 1970 to 1974*

| *Year* | *Shrimp* | | *Total* | |
|---|---|---|---|---|
| | *Volume (tons)* | *Value (US$ × $10^3$)* | *Volume (tons)* | *Value (US$ × $10^3$)* |
| 1970 | 7,333 | 4,278 | 22,060 | 6,959 |
| 1971 | 15,314 | 14,679 | 30,756 | 18,994 |
| 1972 | 23,411 | 29,809 | 41,156 | 34,941 |
| 1973 | 28,787 | 57,562 | 52,178 | 68,185 |
| 1974 | 33,244 | 84,455 | 55,485 | 92,019 |

The inland fishery, where rice farming can be mixed with fish farming, plays a special role in the agro-economy of Indonesia. So far the production of the inland fishery is one-third of the total catch; the main freshwater species cultured and caught are common carp, Java carp, giant gourami and *Tilapia* sp.; the crop from brackish waters and swampy areas mainly comprises milkfish, snakehead, catfish, eels and prawns.

### *Use of the catch*

Table 2 shows the pattern of disposition of the catch in 1974. The pattern of utilization has not changed for several years, except for a gradual increase in freezing from 0.5% in 1968 to 3.1% in 1974; most of the frozen products are exported. It is expected that the figure for fresh fish will increase in the future. Live fish distribution has shown a marked increase due to better handling and communication facilities; however, it should be noted that the proportion of cured fish has decreased.

TABLE 2. *Breakdown of 1974 total catch (1.3 million tons)*

| *Category* | *Percentage of total catch* |
|---|---|
| *Fresh:* Un-iced, completely or incompletely iced and distributed live; mostly for domestic use (some has been exported to Singapore). | 42.0 |
| *Frozen:* Shrimp, frogs legs, tuna and other crustaceans and molluscs; mainly for export | 3.1 |
| *Cured:* All kinds of fish and shell fish; mainly dry salted (salted jelly-fish for export) | 50.0 |
| *Canned:* Oil sardine, milkfish | 1.0 |
| *Reduction:* For poultry and fish feed | very slight |
| *Offal and miscellaneous* | 3.9 |

### *Development of fish utilization*

*Fresh fish handling:* This represents the biggest problem of fish utilization in Indonesia and should have been handled more seriously when the first Five Years'

Development Programme was launched in 1969. The importance of this is not only to switch from the traditional consumption of dried fish (which cannot be consumed in sufficient quantities to meet daily protein requirements) to fresh fish but also to supply fresh raw material for processing purposes (curing, canning, freezing etc).

With regard to the hygienic and organoleptic qualities of the fresh raw material processed for export, it should be pointed out that 60 to 70% of the raw material is supplied by artisanal fishermen; about 30% of this is of poor quality when it arrives at the processing plants and is classified as unfit to be processed for export.

Involvement of the Indonesian fisheries in international trade since 1968 has brought positive results and some consequences throughout the fishery sector, especially in the handling of fresh raw material for export purposes. This in turn should also improve the fresh fish handling for local consumption but still there is much to be done in order to improve the poor conditions.

The production of block ice especially has increased rapidly during the past few years; however, the making of small/fragmentary ice is still limited to a few plants.

Several main species of freshwater fish are distributed alive for local consumption and for export but the techniques and facilities needed still have to be improved.

*Freezing:* The expansion in the production of frozen products is shown in Table 3. The volume and value of refrigerated products is compared to the total volume and value of exports of fishery products from 1968 (when freezing techniques were first applied) to 1974. The products involved are mainly shrimp, frogs legs and tuna.

TABLE 3. *Export of refrigerated and total fishery products from 1968 to 1974*

| *Year* | *Refrigerated products* | | *Total* | |
|---|---|---|---|---|
| | *Volume (tons)* | *Value (US$ × 10³)* | *Volume (tons)* | *Value (US$ × 10³)* |
| | * | * | | |
| 1968 | 5,877 (29.8) | 1,230 (43.5) | 19,717 | 2,822 |
| 1969 | 7,489 (34.9) | 1,212 (49.5) | 21,426 | 2,444 |
| 1970 | 8,773 (39.7) | 4,671 (67.2) | 22,060 | 6,959 |
| 1971 | 19,672 (63.9) | 15,934 (83.8) | 30,756 | 18,994 |
| 1972 | 26,205 (66.3) | 29,428 (88.5) | 39,672 | 33,225 |
| 1973 | 36,846 (70.7) | 61,825 (90.9) | 52,143 | 68,088 |
| 1974 | 40,397 (73.3) | 86,829 (94.0) | 54,485 | 92,019 |

* Percentages of total

Frozen fish for domestic use is at the moment limited to supplying restaurants, supermarkets, hotels and a few consumers.

Air-blast and contact-plate freezers are the most widely used on shore as well as on shrimp trawlers which operate as far as the eastern Indonesian waters. Cryogenic freezing techniques have not been applied so far but when production of cryogens increases (as by-products of some nearly completed petrochemical factories) there may be possibilities for this type of freezing.

*Canning:* Canning was introduced to Indonesia a long time ago but could not develop properly becase there was no domestic tinplate industry or quality control measures. Imports of canned products have increased over the years. At the moment fish canning is concentrated only around the Bali Strait (Muncar, Banyuwangi and Denpasar) where sardines are canned for local consumption.

*Curing:* There has been little apparent improvement in the techniques of curing (salting, drying, smoking, boiling in brine, fermenting etc) except for the use of improved packaging of some speciality products. There is a lack of good quality salt in remote areas where fish are abundant throughout the year. Unfavourable climatic factors and poor handling and sanitary measures resulted in rapid deterioration of cured products. Generally, after two weeks dried salted products become mouldy, rancid and discoloured and are subject to off-flavours and off-odours.

The improvement of curing techniques should have been followed by adjusting all factors contributing to acceptability and prolonging the shelf life, including better packaging and storage at chilled temperature. Around one-half of the cured products are shipped to West Java Province in the island of Java. About one-third of the products are damaged due to poor processing and handling practices during distribution.

*Other methods:* Minced fish has not been produced; a small amount of the catch is reduced to fish flour for the manufacture of feed for pigs, poultry and fish, for which there is an increasing demand.

## Fresh fish marketing

Figures of the last census (1971) showed that 64% of the population of Indonesia inhabited the relatively small islands of Java and Madura while their annual fish production was only 21% of the total. Theoretically, there should be a big demand for fish products in Java but this is not quite true due to the relatively low buying capacity of the people, except those living in the capital, Jakarta, and other big cities.

The problems mentioned above are complicated by the rapid deterioration of fish which make special precautions and efforts necessary in the handling, shipment, landing and distribution of fishery products to big cities and remote areas in Java.

The prices of fishery products show that they could compete with other substitutes. Consumer preference and habits play a role on the marketing of fresh fish.

For several reasons it is necessary to define the term 'fresh fish'. Fresh fish can be defined as various kinds of fishery commodities possessing characteristics very close to newly caught fish. According to the definition, commodities which are classified here as 'fresh fish' are:

(a) Fresh fish, alive: they are distributed alive in water. Most crustaceans and molluscs are sold alive in the market.

(b) Fresh fish, un-iced: this type of fish is marketed when the time and distance between catching and retailing are relatively short.

(c) Fresh fish, chilled: the method of chilling generally practised is icing in crushed block ice. Included in this category are fresh fish for local consumption. and export (to Singapore and some parts of Malaysia) and also fresh fish used as raw material for freezing, mainly for export.

(d) Fresh fish, frozen: products that have been frozen but are sold in a thawed condition as fresh fish. Some of these products are frozen at sea on fishing vessels.

Most of the main species of inland freshwater fish are preferred alive by consumers (especially people from the West Javan region), hotels and restaurants. The preference for live fish is demonstrated by the price drop of 50% as soon as the fish dies. The preference, according to the price the consumers are willing to pay, is: (1) live fish (2) iced, fresh fish (3) frozen fish (4) un-iced, fresh fish.

Almost all fish are bought in 'whole/round' form; only a very small amount is sold as fillets and steaks (eg large fish and frozen products).

### *Pattern of fresh fish marketing*

The structure, prices and chains of distribution, which determine the general pattern of fresh fish marketing in Indonesia, depend on the species of fish, the type of product, the purpose of using the fish for further processing, consumer preference, habits of people of certain regions, buying capacity and some other factors.

Distribution of un-iced fresh fish occurs throughout the archipelago especially where the distance between catching and consumption areas is short. The distribution chain is very simple which means that the fishermen sell their catches directly to the consumers.

High valued fish (mackerel, skipjack, milkfish etc), which are usually iced, are generally marketed to cities around the catching area (distances up to several hundred kilometres). The distribution chain is: catching, auctioning, wholesaling, retailing to consumers. The supply of raw material for the freezing and canning plants also falls within this category. The distribution chain is: fishermen, fish collectors, sometimes through auctions, processors.

Most of the industries which process fishery products for export have their own fleet to provide the raw material. Some of the vessels are refrigerated; a few of these refrigerated vessels process the fish on board ready for export.

Special precautions are taken for live distribution of freshwater species, in order to keep the fish alive throughout marketing and thus to prevent the loss in value if the fish die.

Beside the general pattern mentioned above, there is an increasing activity of fresh fish marketing from the outer islands (Sumatra, Kalimantan and surrounding islands) to the island of Java, to Singapore and some parts of Malaysia. In order to speed up the fresh fish distribution especially to Java, the Government has set up some operational bases in Southern Sumatra and Kalimantan. A coastal fishing port is provided with landing, cold storage and ice-making facilities, a fishing fleet and carriers. While on the island of Java itself some facilities are being completed in order to promote fresh fish distribution.

## Problems

The present problems faced in fresh fish distribution and marketing can be grouped into technological, socio-economic and administrative categories.

### *Technological*

Starting with the point that chilled fresh fish should be cooled as soon as they are removed from the water and that the temperature of the products should be maintained around 0°C during distribution, then all the necessary facilities (ie clean potable water, ample amounts of ice, insulated containers and vehicles, chill stores, display cabinets, etc) have to be provided throughout the distribution channels. At present, the application of refrigeration techniques is still limited to handling and processing of products for export. It is quite disappointing that such discrimination should be exercised between the operation for export activities and those for local consumption, although many ice plants and small cold stores have been built within the past few years.

Live fish distribution chains, especially at the collecting points and live fish market, are another field which has to be expanded not only due to the high potential of fresh waters available but also the better price the fish farmers could earn from local and foreign markets.

### *Socio-economic*

The promotion of fresh fish distribution, from the outer islands to Java, is handicapped by the large number of facilities which have to be provided and is also complicated by the lower income of those who are in desperate need of protein ie the majority of Java's inhabitants.

Facilities required to guarantee the wholesomeness of the products and the health of the consumers cannot be economically viable. In this case, the Government has to provide public facilities and favourable conditions for the private sector.

### *Administrative*

Considering the seriousness of the problems (protein need, health, welfare etc) involved in the distribution of fresh fish to the people, an administrative approach should be applied to handle this matter, that is through setting up an effective quality control and inspection system throughout the fishery.

## Conclusions and recommendations

An even distribution of fishery products in general, and fresh fish in particular, has to be carefully planned and carried out in Indonesia especially due to the imbalanced geographical distribution of the population. Java is the most densely populated island (64% of the total population) but protein intake is very low since the average income is low and the contribution to the total catch is only 21%. It should be possible to increase and promote the consumption of fresh fish when one takes into consideration the wealth of Indonesia waters and the agrarian nature of the country.

Beside technological and administrative aspects, all fishery activities including utilization and distribution of the products should be approached socio-economically with the aim of levelling the social welfare by improvement of income of the lowest group (fishermen), employment opportunities, environmental (hygienic) conditions, etc.

Quality control and fish inspection principles have to be laid down throughout the fishery and not just to deal with the processing of export commodities.

Although the application of refrigeration techniques for export activities has proved to be successful, the planning and programming of future fish utilization and distribution should be carefully formulated through a thorough study of the existing physical and socio-economic conditions and situations.

The potential of the inland fishery has not been fully exploited; domestic and export markets could be enlarged by marketing live inland fish. Better systems and facilities should be introduced for this. The public waters in south Sumatra and Kalimantan, which have great potential, could be better utilized; an intensive study on the suitability of the freshwater fish for icing, freezing and various types of curing should be carried out.

# Relationship of meat yield to round weight of milkfish (*Chanos chanos,* Forskal)

**Patricia T. Arroyo**
University of the Philippines
**K. M. Apolinario, T. D. Santos, L. G. de la Cruz, A. Abante and E. A. Santos**
National Institute of Science and Technology, Philippines

## Summary

Information on the meat yields of fish in relation to round weight is important in the fish industry, particularly in its cooking and processing. In the case of pond-raised fish, fish farmers would make use of meat yield/round weight data in the determination of the ideal fish weight for harvest; fish processors are interested in the percentage edible portion of each delivery of a certain size fish; consumers are also concerned with the market weight of fish that would provide them with the maximum edible portion.

The objective of this study is to show the relationship of milkfish meat yield to increasing round weight from less than 100 g to 1200 g. A total of 240 milkfish obtained directly from a commercial fish-pond was used in this study. Immediately after capture, 20 samples were taken for each 100 g round weight interval.

Two preliminary studies using milkfish of different sources showed similar results. These clearly suggest that milkfish at 600 g round weight yield the maximum percentage edible portion beyond which there is no statistically significant increase.

Other parameters, such as the percentages of liver, bones, head, tail and entrails, were also determined. Linear regression analyses of these parameters versus round weight were also conducted and are included in the full text of this paper.

## Résumé

Des informations sur la production de chair de poisson par rapport au poids brut sont importantes pour l'industrie du poisson, en particulier en ce qui concerne sa cuisson et sa préparation. Dans le cas de poisson de vivier, les éleveurs de poisson utiliseraient le rapport production de chair/poids brut dans la détermination du poids idéal de poisson pour le rendement; ceux qui traitent le poisson sont intéressés par la partie comestible évaluée en pourcentage de chaque livraison d'un poisson d'une certaine taille et les consommateurs sont également concernés par le poids commercial de poisson qui leur fournirait la quantité maximum comestible.

L'objectif de cette étude est de montrer la relation entre la production de chair de poisson blanc et l'augmentation de poids de moins de 100 g jusqu'à 1200 g. Un total de 240 poissons blanc obtenus directement d'un établissement de vente de poisson a été utilisé pour cette étude. Immédiatement après la peche, 20 échantillons ont été prélevés pour chaque intervalle de poids de 100 g.

Deux études préliminaires utilisant le poisson blanc de sources différentes ont montré des résultats semblables. Ceux-ci suggèrent nettement que le poisson blanc à un poids brut de 600 g fournit le pourcentage maximum de produit comestible au delà duquel il n'y a pas d'augmentation statistiquement significative.

D'autres paramètres tels que la pourcentage du foie, des arêtes, de la tête, de la queue et des entrailles ont également été déterminés. Les analyses de régression linéaire de ces paramètres par rapport au poids brut ont également été effectuées et sont données dans le texte complet de l'article.

## Resumen

Es importante la información sobre la producción de carne del pescado en relación con el peso del pescado entero en la industria pesquera, especialmente en el cocinado y elaboración. En el caso de los pescados de vivero, los productores podrían utilizar la producción de carne: los datos sobre el peso del pescado entero para la determinación del peso ideal del pescado para la recolección; los elaboradores de pescado están interesados en el porcentaje de la porción comestible de cada entrega de un pescado de un determinado tamaño; y a los consumidores también les interesa que el peso de mercado del pescado que les suministren tenga un máximo de porción comestible.

El objetivo de este estudio es mostrar la relación de la producción de carne de sabalote con el peso del pescado entero en incremento desde menos de 100 g hasta 1200 g. En este estudio se han utilizado un total de 240 ejemplares de carne de sabalote procedentes directamente de un vivero comercial. Inmediatamente después de la captura se tomaron 20 muestras para cada 100 g de intervalo de peso.

En dos estudios previos usando ejemplares de sabalote de distintas procedencias se obtuvieron resultados similares. Estos estudios sugieren claramente que los ejemplares de 600 g de peso de pescado entero producen un mámimo de porción comestible, más allá del cual no hay un incremento estadísticamente significativo.

También se determinaron otros parámetros como el porcentaje de hígado, de huesos, de cabeza, de cola y de entrañas, y se realizaron análisis de la regressión lineal de estos parámetros en relación con el peso del pescado entero, los cuales se incluyen en el texto completo del artículo.

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## Introduction

Information on the meat yield of fish in relation to round weight is important in the fish industry particularly in the marketing and processing sectors. In the case of pond-raised fish, fish farmers would make use of meat yield/round weight data in the determination of the ideal fish weight for harvest. Fish processors are interested in the percentage edible portion of each delivery of a certain size fish; consumers are also conconcerned with the market weight of fish that would provide them with the maximum edible portion.

In the Philippines, more than 90 per cent of the fish-pond production consists of milkfish. Milkfish production in 1973 amounted to 99.6 thousand tonnes and is expected to increase steadily due to an expansion of the fish-pond areas and improved technology. It is a common practice in the country to hold milkfish in ponds for 3 to 6 months and then sell them fresh at weights of 150 to 600 g (The Philippine Council for Agricultural Research, 1976). No work on the meat yield/round weight relationship of milkfish has been found in the literature. Studies by Rabanal *et al.* (1952), Juliano *et al.* (1970) and Grover and Juliano (1975) on the weight of milkfish in relation to fish length have been conducted from the standpoint of assessing the nutritional value of the habitat of milkfish and not from its processing aspect. Gonzalez (1976) determined the weight conversion factors of the cooked edible portion of milkfish (fried and boiled) to its raw edible portion, for use in the evaluation of dietary surveys. However, the milkfish studies were carried out using a relatively constant size of fish (an average of 26 cm in length).

The main objective of this study was to show the changes in the meat yield from milkfish of increasing round weight from less than 100 g to 1,200 g. Minor objectives were to determine the carcass composition ie the percentage head, skin, tail, entrails, bone and liver of milkfish, and to determine the nature of the growth of the fish (isometrically or not) used in this study based on length/weight relationship studies.

## Experimental

From November 1975 to January 1976 milkfish samples ranging from less than 100 g to 1,200 g round weight were randomly harvested from a commercial fish-pond in Sukat, Paranaque in Metropolitan Manilla. For each 100 g round weight interval, 20 fish samples were taken. The feed in all cases consisted of filamentous green algae, belonging to the genera *Enteromorpha* and *Cladophora*, and the red alga of the genus *Gracilaria*.

Immediately after harvest, the length of the fish was measured using a rule; both fork length (from the tip of the central rays of the caudal fin) and total length were recorded. The fish were then weighed using a spring balance with a sensitivity of 10 g.

Approximately one hour after death, the fish were cut into a butterfly on the dorsal side, carefully eviscerated and then deboned using tweezers or forceps. The meat was scraped from the skin, head and tail of the deboned fish. With the use of sharp scissors, the head and tail were separated from the skin and the liver was carefully separated from the gut. The meat, head, skin (with scales), tail, entrails (including gills), bone and liver were weighed using a trip balance with a sensitivity of 0.1 g. The fish were not washed.

The percentages of these various parts were then computed from the round weight as follows:

$$\text{\% Milkfish part} = \frac{\text{weight of milkfish part}}{\text{round weight}} \times 100$$

Linear regression analyses of these percentage figures versus the round weight for every 200 g round weight interval were conducted at the University of the Philippines Computer Center.

Linear regression analyses of the fork and total length versus round weight for every 200 g round weight interval were also determined. The nature of the growth of the fish, as to whether they grew isometrically or not, was also studied based on the length/weight relationship. The following equation was used:

$\text{Log } W = \text{Log } a + b \text{ Log } L$
where $W$ = weight of fish in g
$L$ = total or fork length in mm

Log a and b were empirically determined where b is the slope of the linear regression curve; its value indicates whether the fish has grown with or without a change in shape or specific gravity. If b is equal to 3.0, it would indicate that the fish grew without any change in shape or specific gravity i.e. isometrically. Values for b of less than 3.0 would indicate that the fish became more slender as they increased in length while b values greater than 3.0 would indicate the reverse. Log a is the y intercept of the linear regression curve (Royce, 1972; Grover and Juliano, 1975).

## Results and discussion

In Table 1, it may be seen that the percentage meat yield increased linearly at the 201–600 g round weight intervals ($p \leq 0.5\%$). These results clearly suggest that milkfish at 600 g round weight yield the maximum percentage of edible tissue. Beyond this size there is no stastically significant increase. Random interviews with fish vendors in Metropolitan Manila showed that milkfish at 100–200 g round weight were sold at ₱5.00*per kg; those at 300–500 g round weight, ₱7.00 per kg; at 600–700 g round weight; ₱8.00 per kg; at 800–900 g round weight, ₱9.00 per kg; and those at 1000–1200 g round weight, ₱12.00 per kg.

Feed conversion ratios for pond-raised milkfish were not included in this study but further investigation is strongly recommended to determine whether the culture of milkfish up to 600 g round weight is sound from the point of view of aquaculture economics.

The maximum average percentage of edible tissue, among the round weight intervals studied, was 64.69 ± 1.21% at the 1001–1200 g interval. The average percentage meat yield in the study by Gonzalez (1976) was 67.4%; this higher value may be attributed to the washing operation of the 'cut up' fish prior to cooking, while in this study the fish were not washed.

Table 2 shows that the percentage head weight decreased from the 1–800 g round weight intervals which was significant for the 1–200 g and 201–400 g round weight intervals ($p \leq 0.5$ and 1.0% respectively). Beyond 800 g round weight there was a slight increase which was statistically significant at the 1001–1200 g round weight interval ($p \leq 0.5\%$).

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* 1 Peso (₱) = £0.08, at June 1976.

TABLE 1. *Linear regression analysis of average milkfish meat weight and average percentage meat yield for different round weight intervals*

| | *Milkfish meat weight (g)* | | | | *Percentage meat yield* | | | |
|---|---|---|---|---|---|---|---|---|
| *Round weight interval (g)* | *Average* | *Standard deviation* | *F value* | *Remark* | *Average* | *Standard deviation* | *F value* | *Remark* |
| 1–200 (104 ± 42) | 56.18 | ± 24.4 | 1486.0 | $p \leq 0.5\%$ | 53.69 | ±4.17 | 2.48410 | N.S. |
| 201–400 (312 ± 69) | 180.42 | ± 47.8 | 1025.7 | $p \leq 0.5\%$ | 57.30 | ±3.80 | 20.97577 | $p \leq 0.5\%$ |
| 401–600 (485 ± 59) | 297.84 | ± 48.2 | 831.5 | $p \leq 0.5\%$ | 61.13 | ±3.02 | 49.77704 | $p \leq 0.5\%$ |
| 601–800 (695 ± 60) | 441.00 | ± 42.0 | 232.0 | $p \leq 0.5\%$ | 63.40 | ±2.24 | 0.12886 | N.S. |
| 801–1000 (853 ± 53) | 571.60 | ± 40.5 | 314.1 | $p \leq 0.5\%$ | 63.97 | ±1.59 | 3.50297 | N.S. |
| 1001–1200 (1096 ± 62) | 709.40 | ± 45.9 | 472.2 | $p \leq 0.5\%$ | 64.69 | ±1.21 | 3.19369 | N.S. |

N.S. Not significant

TABLE 2. *Linear regression analysis of average milkfish head weight and average percentage head for different round weight intervals*

| | *Milkfish head weight (g)* | | | | *Percentage head* | | | |
|---|---|---|---|---|---|---|---|---|
| *Round weight interval (g)* | *Average* | *Standard deviation* | *F value* | *Remark* | *Average* | *Standard deviation* | *F value* | *Remark* |
| 1–200 g | 10.56 | ±4.2 | 147.0 | $p \leq 0.5\%$ | 10.36 | ±1.73 | 4.97088 | $p \leq 0.5\%$ |
| 201–400 g | 28.25 | ±5.6 | 149.0 | $p \leq 0.5\%$ | 9.14 | ±1.01 | 8.32778 | $p \leq 1.0\%$ |
| 401–600 g | 42.69 | ±5.6 | 172.9 | $p \leq 0.5\%$ | 8.79 | ±0.51 | 0.07019 | N.S. |
| 601–800 g | 59.39 | ±6.6 | 21.7 | $p \leq 0.5\%$ | 8.56 | ±0.74 | 1.94165 | N.S. |
| 801–1000 g | 77.46 | ±6.9 | 30.8 | $p \leq 0.5\%$ | 8.67 | ±0.58 | 0.000 | N.S. |
| 1001–1200 g | 97.26 | ±10.6 | 96.1 | $p \leq 0.5\%$ | 8.86 | ±0.63 | 13.94118 | $p \leq 0.5\%$ |

From Table 3 it can be seen that the percentage skin increased between 1 and 600 g and levelled off beyond that. However, the increase was not statistically significant.

The percentage accounted for by the tail decreased between 1 and 600 g round weight. This change was statistically significant at the 1–200 g round weight interval ($p \leq 0.5\%$). Beyond 600 g, there was a slight increase but it was not significant (Table 4).

The percentage accounted for by the entrails decreased with increasing round weight; this was statistically significant at the 201–400 g ($p \leq 0.5\%$) and the 801–1000 g ($p \leq 0.5\%$) round weight intervals (Table 5).

TABLE 3. *Linear regression analysis of milkfish skin weight and average percentage skin for different round weight intervals*

| | *Milkfish skin weight (g)* | | | | *Percentage skin* | | | |
|---|---|---|---|---|---|---|---|---|
| *Round weight interval (g)* | *Average* | *Standard deviation* | *F value* | *Remark* | *Average* | *Standard deviation* | *F value* | *Remark* |
| 1–200 | 9.73 | ±4.5 | 207.2 | $p \leq 0.5\%$ | 9.29 | ±1.79 | 0.49 | N.S. |
| 201–400 | 31.50 | ±8.0 | 122.5 | $p \leq 0.5\%$ | 10.09 | ±1.14 | 0.00 | N.S. |
| 401–600 | 50.84 | ±6.3 | 77.8 | $p \leq 0.5\%$ | 10.50 | ±0.78 | 3.06 | N.S. |
| 601–800 | 72.62 | ±11.8 | 16.7 | $p \leq 0.5\%$ | 10.45 | ±1.41 | 0.01 | N.S. |
| 801–1000 | 93.70 | ±9.7 | 11.0 | $p \leq 0.5\%$ | 10.50 | ±0.96 | 0.62 | N.S. |
| 1001–1200 | 113.53 | ±8.3 | 18.4 | $p \leq 0.5\%$ | 10.36 | ±0.67 | 2.33 | N.S. |

TABLE 4. *Linear regression analysis of average milkfish tail weight and average percentage tail for different round weight intervals*

| | *Milkfish tail weight (g)* | | | | *Percentage tail* | | | |
|---|---|---|---|---|---|---|---|---|
| *Round weight interval (g)* | *Average* | *Standard deviation* | *F value* | *Remark* | *Average* | *Standard deviation* | *F value* | *Remark* |
| 1–200 | 2.41 | ±0.61 | 12.05 | $p \leq 0.5\%$ | 2.60 | ±0.91 | 53.04 | $p \leq 0.5\%$ |
| 201–400 | 5.48 | ±1.38 | 25.62 | $p \leq 0.5\%$ | 1.78 | ±0.40 | 2.30 | N.S. |
| 401–600 | 8.05 | ±1.40 | 47.11 | $p \leq 0.5\%$ | 1.66 | ±0.19 | 0.10 | N.S. |
| 601–800 | 12.27 | ±2.14 | 24.24 | $p \leq 0.5\%$ | 1.74 | ±0.27 | 0.38 | N.S. |
| 801–1000 | 16.23 | ±2.11 | 16.66 | $p \leq 0.5\%$ | 1.82 | ±0.20 | 0.43 | N.S. |
| 1001–1200 | 19.83 | ±1.64 | 32.80 | $p \leq 0.5\%$ | 1.81 | ±0.11 | 0.00 | N.S. |

TABLE 5. *Linear regression analysis of average milkfish entrails weight and average percentage entrails for different round weight intervals*

| | *Milkfish entrails weight (g)* | | | | *Percentage entrails* | | | |
|---|---|---|---|---|---|---|---|---|
| *Round weight interval (g)* | *Average (g)* | *Standard deviation* | *F value* | *Remark* | *Average* | *Standard deviation* | *F value* | *Remark* |
| 1–200 | 10.65 | ±4.85 | 91.98 | $p \leq 0.5\%$ | 10.5 | ±2.80 | 1.84 | N.S. |
| 201–400 | 29.56 | ±6.17 | 129.44 | $p \leq 0.5\%$ | 9.5 | ±1.05 | 4.84 | $p \leq 0.5\%$ |
| 401–600 | 40.19 | ±6.33 | 17.78 | $p \leq 0.5\%$ | 8.3 | ±1.14 | 2.75 | N.S. |
| 601–800 | 56.78 | ±8.85 | 6.72 | $p \leq 2.5\%$ | 8.2 | ±1.22 | 1.36 | N.S. |
| 801–1000 | 63.60 | ±6.93 | 0.78 | N.S. | 7.2 | ±0.95 | 18.60 | $p \leq 0.5\%$ |
| 1001–1200 | 74.35 | ±8.13 | 2.10 | N.S. | 6.79 | ±0.78 | 3.03 | N.S. |

TABLE 6. *Linear regression analysis of average milkfish bone weight and average percentage bone for different round weight intervals*

| | *Milkfish bone weight (g)* | | | | *Percentage bone* | | | |
|---|---|---|---|---|---|---|---|---|
| *Round weight interval (g)* | *Average* | *Standard deviation* | *F value* | *Remark* | *Average* | *Standard deviation* | *F value* | *Remark* |
| 1–200 | 4.88 | ±1.5 | 89.0 | $p \leqslant 0.5\%$ | 4.96 | ±1.02 | 26.45 | $p \leqslant 0.5\%$ |
| 201–400 | 12.95 | ±3.2 | 74.4 | $p \leqslant 0.5\%$ | 4.16 | ±0.55 | 0.49 | N.S. |
| 401–600 | 19.42 | ±3.5 | 33.8 | $p \leqslant 0.5\%$ | 4.00 | ±0.57 | 0.00688 | N.S. |
| 601–800 | 28.02 | ±3.6 | 34.0 | $p \leqslant 0.5\%$ | 4.03 | ±0.38 | 0.00857 | N.S. |
| 801–1000 | 37.20 | ±4.2 | 43.0 | $p \leqslant 0.5\%$ | 4.16 | ±0.34 | 3.19376 | N.S. |
| 1001–1200 | 47.64 | ±5.3 | 55.9 | $p \leqslant 0.5\%$ | 4.34 | ±0.34 | 5.90408 | $p \leqslant 2.5\%$ |

TABLE 7. *Linear regression analysis of average milkfish liver weight and average percentage liver for different weight intervals*

| | *Milkfish liver weight (g)* | | | | *Percentage liver* | | | |
|---|---|---|---|---|---|---|---|---|
| *Round weight interval (g)* | *Average* | *Standard deviation* | *F value* | *Remark* | *Average* | *Standard deviation* | *F value* | *Remark* |
| 1–200 | 1.82 | ±0.67 | 56.5 | $p \leqslant 0.5\%$ | 1.77 | ±0.46 | 2.90 | N.S. |
| 201–400 | 3.29 | ±0.74 | 18.0 | $p \leqslant 0.5\%$ | 1.07 | ±0.22 | 8.98 | $p \leqslant 0.5\%$ |
| 401–600 | 4.00 | ±0.93 | 1.42 | N.S. | 0.83 | ±0.21 | 5.39 | $p \leqslant 5.0\%$ |
| 601–800 | 5.56 | ±1.37 | 2.75 | N.S. | 0.81 | ±0.24 | 14.68 | $p \leqslant 0.5\%$ |
| 801–1000 | 6.54 | ±1.36 | 0.00467 | N.S. | 0.73 | ±0.16 | 3.69 | N.S. |
| 1001–1200 | 7.46 | ±1.52 | 0.23397 | N.S. | 0.68 | ±0.15 | 1.45 | N.S. |

Table 6 indicates that the percentage bone weight decreased with increasing round weight from 1–600 g which was significant only at the 1–200 g round weight interval ($p \leqslant 0.5\%$). Beyond 600 g there was a slight increase which was statistically significant at the 1001–1200 g round weight interval ($p \leqslant 2.5\%$). Percentage bone weight values in this study would also be helpful to deboned milkfish processors. Deboned milkfish is fast becoming a popular market form of milkfish in the Philippines since milkfish with bones are difficult to eat due to the intricate bone structure.

In Table 7 the percentage liver decreased with increasing round weight which was statistically significant for the 200–800 g round weight intervals ($p \leqslant 0.5\%$).

In all the round weight interval studies, both fork and total length increased linearly with round weight as expected.

The overall fork length/weight relationship gave the equation:
$\text{Log } W = -5.21202 + 3.18312 \text{ Log } L$

That of total length/weight relationship gave a similar equation:
$\text{Log } W = -5.15049 + 3.02991 \text{ Log } L$

Since the value for b is more than 3.0 in both cases, this suggests that the fish measured were heavier in form at the longer lengths.

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## References

**Grover, J. H. & Juliano, R. O.** (1976) Length-weight relationship of pond-raised milkfish. *Aquaculture* 7 (4), 339–346.

**Gonzalez, L. T.** (1976) Determination of weight conversion factors of some Philippine fish. M. S. thesis in foods and nutrition. University of the Philippines College of Home Economics, Q.C. (in progress).

**Juliano, R. O., Baes, A. V., Ventura, R. F. & Isidro, A. O.** (1970). Weight-length relationship and growth of *Chanos chanos* (Forskal) grown in freshwater ponds. *Nat. Appl. Sci. Bull.* 22, 113–131.

**The Philippine Council for Agricultural Research.** (1976) *The Philippines recommends for bangus.* Los Banos, Laguna, Philippines, 41 pp.

**Rabanal, H. R., Esguerra, R. S. and Delmendo, M. N.** (1952) Studies on the rate of growth of milkfish or 'bangos' *Chanos chanos* (Forskal) under cultivation. *Indo. Pacific Fish Council Proc.* (c 52) Tech. 15, Sec. II, p. 9.

**Royce, W. F.** (1972) *Introduction to fishery sciences.* New York; Academic Press, pp. 148–153.

# Biochemical studies on some commercially important fish of Shatt Al-Arab and the Gulf

**K. Das, S. K. Al-Nasiri, N. A. Shukri and K. P. Sharma**
University of Basrah, Iraq

### Summary

The paper mainly deals with the chemical composition of commercially important fishes of Shatt Al-Arab and the Gulf in relation to their nutritive values. It also includes a study of their keeping quality at a refrigerated temperature (8°C). In addition, the work has further been extended to an investigation of possible contaminants from oil pollutants in the area.

From the chemical analysis, it was observed that *Pseudosciaena aneus* and *Ilisha filigera* contain maximum moisture and protein, respectively, whereas *Hilsa ilisha* was rich in both fat and ash. Moisture and protein were found to be lowest in *Hilsa ilisha*, fat in *Pseudosciaena aneus* and ash in *Ilisha filigera*.

The physico-chemical study on their storage quality showed that *Barbus xenthopterus* and *Pampus argentius* stand quite well for consumption even up to two weeks, while *Chirocentrus dorab* is spoiled within one week.

### Résumé

Cet article traite tout particulièrement de la composition chimique du poisson du Shatt Al-Arab et du Golfe important du point de vue commercial en ce qui concerne leur valeur nutritive. Il comporte également une étude de sa qualité de conservation à une température de réfrigération (8°C). En outre, ce travail a procédé à une recherche des contaminations possibles par des polluants huileux dans cette zone.

L'analyse chimique a démontré que *Pseudosciaenea aneus* et *Ilisha filigera* contiennent respectivement la quantité la plus forte en humidité et en protéines tandis que *Hilsa ilisha* était riche à la fois en corps gras et en résidus. On a trouvé que l'humidité et les protéines étaient à leur taux le plus bas chez *Hilsa ilisha*, les corps gras chez *Pseudosciaena aneus* et les résidus chez *Ilisha filigera*.

L'étude physico-chimique de leur qualité de conservation a montré que *Barbus xenthopterus* et *Pampus argentius* conviennent très bien à la consommation, même après deux semaines, tandis que *Chirocentrus dorab* est détérioré en une semaine.

### Resumen

El artículo trata principalmente de la composición química de los pescados comercialmente importantes de Shatt Al-Arab y del Golfo en relación con sus valores nutritivos. También incluye un estudio sobre su calidad de conservación a temperatura de refrigeración (8°C). Además, el trabajo se ha extendido a una investigación sobre los posibles contaminantes procedentes de los agentes polucionantes del petróleo.

Por análisis químico se ha observado que el *Pseudosciaena aneus* y el *Ilisha filigera* contienen un máximo de humedad y proteinas respectivamente, mientras que el *Hilsa ilisha* es rico tanto en grasas como en cenizas. Las cantidades más bajas de humedad y proteínas se hallaron en *Hilsa ilisha*, de grasa en *Pseudosciaena aneus* y de ceniza en *Ilisha filigera*.

El estudio físico-químico de su calidad para el almacenamiento mostró que el *Barbus xenthopterus* y el *Pampus argentius* se mantienen bastante bien para el consumo hasta dos semanas, mientras que el *Chirocentrus dorab* se estropea en el plazo de una semana.

### Introduction

A knowledge of the chemical composition of fish is an important step in the evaluation of its nutritive value. Some important studies on the chemical composition of fishes have been reported by Love (1970), Neuhaus and Halver (1969) and Wiechers and Dreosti (1961). Proximate analyses have also been reported by Natrajan and Sreenivasan (1961) and Paniaotova and Bailozov (1960) but no such information is available for fish in the Gulf region. Keeping this in mind, part of the present work was devoted to the preliminary analysis of a few commercially important fish of Shatt Al-Arab and the Gulf; in the industrial processing of fish, a thorough knowledge of their chemical composition and of their availability is of paramount importance. Prior information on fat or protein content is necessary to study the production of fish pickles, canned fish or other by-products.

A survey of the literature reveals that many workers have devoted their attention only to proximate analysis but a few, such as Khawaja and Jafri (1967), Pawar and Magar (1965) and Tomlison *et al.* (1961) have dealt with the biochemical changes in fish due to storage at elevated temperatures. A detailed physico-chemical study was, therefore, undertaken to establish the keeping time of some fish at refrigerated temperatures.

As a result of crude oil pollution, it is likely that fish will be contaminated with polycyclic aromatic hydrocarbons (PAH) or other products associated with the use of petroleum. Junghams (1974) and Sullivan (1974) have indicated that, due to petroleum contamination, the amount of benzo(a)pyrene (BP) in sea fish is considerably higher than that in freshwater fish. During oil treatment with detergents, oil particles (of 0.5 μm or less), which are easily digested and assimilated by the fish, are produced. At present, there is little information on their toxicological effects on human health but these may cause many other serious problems as reported by Halstead (1972). The production of fish protein concentrate will become complicated due to contamination with hydrocarbons, which are protein-bound and cannot be removed by normal extraction processes. Many fish are killed by crude oil. The hydrocarbon particle of 0.5 μm, if absorbed through the intestinal wall, can cause damage to the liver. A more drastic effect, such as cancer from petroleum pollutants, has also been reported by Pearson (1970). In view of the serious effects of this type of pollutant in the human system, the present study was extended to the analysis of possible oil contamination.

## Materials and methods

Fresh fish samples were collected from Ashar's fish market in Basrah. Flesh was taken for analysis from the region just below the dorsal fin after removal of the skin. Precautions were taken to avoid bones. Moisture, protein, fat and ash were determined by the standard AOAC procedures (1965). The results are recorded as the average of at least three estimations and expressed as percentages on a wet weight basis.

The determination of freshness was conducted by keeping the fish in sealed polythene bags from one to three weeks in the lower chamber of the refrigerator (approx. 8°C). Physical studies were carried out using some of the organoleptic tests outlined by Burgess *et al.* (1967); estimates of the proximate composition of the same fish were also made at different intervals and total volatile nitrogen (TVN) was determined by the method reported by Pearson (1970).

The procedure adopted for the isolation and identification of hydrocarbons involved the preparation of samples, extraction by suitable solvents and separation by silica gel column chromatography as described by Warner (1974). The final identification was by a fluorescence technique. In a typical experiment, the digestion was carried out by mixing 5 g of blended fish flesh with 2 g of 4N NaOH and heating at 90°C for 2 hours; diethyl ether (25 $cm^3$) was used for the extraction. The resulting extract was then used for fractionation by column chromatography. The size of the column was 1.3 x 12 cm packed with 10 g of silica gel activated at 170°C. The first fraction was eluted with ether, the other two resolutions were from chloroform and methanol using 25 $cm^3$ of each. These fractions were used for the fluorescence study.

## Results and discussion

### *Chemical analysis*

Results of the chemical analysis of the fishes are shown in Table 1. It can be seen that the moisture content was highest in jewfish and lowest in sboor and hamam. Jewelled shad and shabout contained the highest protein levels and sboor and pomfret the lowest. The results also show that sboor contain the greatest quantity of fat in comparison with the other fish particularly shanak and jewfish in which the fat content was less than 1%. In all fish, except jewelled shad, the ash content ranged from 1.16% for pomfret to 1.87% for sboor.

From the results of analyses on some of the same fish from different waters (CSIR, 1962), it was noticed that moisture, protein and ash content in most of our fish were roughly the same. Only in sboor was moisture found to be remarkably high; in the same fish, fat was found to be 9.85% as compared to 19.4% in the other country. The relatively high moisture content and low fat content of sboor in this region may be due to the fact that the fish were caught after a long migration. Jewelled shad, sboor and silver bar were found to have higher protein contents.

Jewelled shad, shanak and jewfish, which have low fat and high protein values, may be suitable for canning and smoking. Similarly fish with a high nutrient content, such as gattan, shabout and pomfret, and which are abundantly available, may be suitable for the fresh market as well as for storage. Sboor, which have a high level of fat, may be a good source of fish oil. Fish with a high protein content such as silver bar, but which are not much favoured for fresh consumption, may be diverted to fish protein concentrate production.

### *Keeping quality*

Physical and biochemical changes during storage are presented in Tables 2 and 3.

The physical characteristics of the fish during storage in the refrigerator showed that some fish deteriorate more quickly than others. The original physical properties

## Results and discussion

TABLE 1. *Chemical analysis of some commercially important fish*

| *Scientific name* | *Common/local name* | *Standard length (mm)* | *Weight (g)* | *Average values (%)* Moisture | Protein N x 6.25 | Fat | Ash |
|---|---|---|---|---|---|---|---|
| *Barbus xenthopterus* | Gattan[a] | 290 | 480 | 75.96 | 21.68 | 1.82 | 1.50 |
| *Barbus sharpeyi* | Bunni[a] | 220 | 268 | 78.34 | 18.18 | 2.00 | 1.40 |
| *Barbus grypus* | Shabout[a] | 360 | 510 | 77.31 | 22.09 | 1.23 | 1.21 |
| *Pampus argentius* | Grey pomfret[b] | 210 | 490 | 77.93 | 17.91 | 2.00 | 1.16 |
| *Pseudosciaena aneus* | Jewfish[b] | 220 | 352 | 79.09 | 19.66 | 0.55 | 1.33 |
| *Chirocentrus dorab* | Silver bar[b] | 500 | 630 | 76.68 | 21.47 | 2.78 | 1.68 |
| *Ilisha filigera* | Jewelled shad[b] | 300 | 390 | 75.60 | 23.03 | 1.03 | 0.44 |
| *Caranx kalla* | Hamam[b] | 260 | 272 | 72.69 | 19.62 | 2.71 | 1.46 |
| *Sparus berda* | Shanak[b] | 260 | 388 | 77.59 | 19.95 | 0.66 | 1.34 |
| *Hilsa ilisha* | Sboor[c] | 270 | 372 | 71.22 | 17.02 | 9.85 | 1.87 |

a Freshwater fish
b Marine
c Both

TABLE 2. *Assessments of freshness by organoleptic tests after one week's storage*

| *Name of fish* | *Gills* | *Odour* | *Appearance* | *Texture* | *Eye* | *Colour* | *Grade* |
|---|---|---|---|---|---|---|---|
| Gattan | Bright red, no bacterial slime, outer slime transparent | Fresh seaweedy | Bright, shiny, kidney bright red, slightly slimy | Does not leave finger impressions, body firm | Fresh | Bright and shiny | I |
| Bunni | Bright red, no bacterial slime, outer slime transparent | Seaweedy | Bright, shiny, kidney bright red, slightly slimy | Finger impressions retained, body not very firm | Fresh | Bright and shiny | I |
| Sboor | Bright red, no bacterial slime | Seaweedy | Bright, shiny, kidney bright red, slimy skin | Firm, elastic to finger touch | Fresh, convex black pupil, translucent cornea | No discoloration | I |
| Grey pomfret | Bright red, no bacterial slime, outer slime water transparent | Fresh seaweedy | Bright, shiny kidney bright red, slightly slimy | Not very firm, elastic to finger touch | Fresh | Shiny | I |
| Silver bar | Dark brown | Caprylic | Little bright, kidney brown in colour, slimy skin | Retained finger indentations | Slightly sunken, translucent | Bright and shiny | II |

TABLE 3. *Biochemical changes of fish stored in a refrigerator*

| *Name of fish* | *Length of storage (weeks)* | *Average values (%)* Moisture | Protein N x 6.25 | Fat | Ash | *TVN mg/100 g* |
|---|---|---|---|---|---|---|
| Gattan | 1 | 77.50 | 20.87 | 1.75 | 1.30 | 20 |
| | 2 | 77.27 | 19.68 | 1.60 | 1.00 | 28 |
| | 3 | 78.54 | 19.52 | 1.25 | 0.80 | 37 |
| Bunni | 1 | 79.00 | 17.76 | 1.74 | 1.29 | 29 |
| | 2 | 78.92 | 16.28 | 1.06 | 1.14 | 36 |
| | 3 | 81.30 | 15.39 | 0.94 | 0.92 | 45 |
| Sboor | 1 | 71.33 | 15.79 | 8.80 | 1.36 | 39 |
| | 2 | 72.13 | 14.96 | 7.99 | 1.11 | 45 |
| | 3 | 73.40 | 12.92 | 6.97 | 0.68 | 50 |
| Grey pomfret | 1 | 78.68 | 15.38 | 0.77 | 1.13 | 22 |
| | 2 | 81.18 | 15.29 | 0.70 | 0.87 | 34 |
| | 3 | 82.05 | 14.76 | 0.60 | 0.82 | 42 |
| Silver bar | 1 | 77.29 | 16.89 | 0.90 | 1.32 | 40 |
| | 2 | 78.59 | 16.30 | 0.80 | 1.10 | 54 |
| | 3 | 81.73 | 15.34 | 0.61 | 0.68 | 60 |

were still found in gattan and grey pomfret after two weeks' storage, but not in silver bar. It is interesting to note that bunni showed distinct dark patches of mould on the ventral surface from the second week onwards which resulted in bursting of the belly. The major signs of spoilage were observed to be softness of flesh and its separation from the bones, depression of the eyes, ammoniacal odour and bleaching of the gills. The degree of decompostion during storage in relation to the above criteria was observed in decreasing order: silver bar, sboor, bunni, pomfret and gattan.

Changes in chemical composition in gattan, bunni, sboor, pomfret and silver bar were also studied. Protein, fat and ash showed a declining trend whilst moisture and TVN rose during storage. One of the possible reasons for the decrease in protein, fat and ash is the observed loss of slimy mucous-like substances from the fish during storage. It was obvious that these nutrients were partly lost through the mucus. Secondly, the decrease may be due, in part, to microbial, enzymatic or similar decomposition. The increase in moisture, on the other hand, is difficult to explain but may be due to an absorption of vapour from the surroundings by the sample during estimation. It was also observed that the value for TVN increased considerably in all the fish during the three weeks' storage. A marked increase was observed in silver bar but was not so significant in the case of gattan.

Results of both physical and chemical observations in keeping quality were found to be in agreement. Table 2 shows that the concentration of mucus was very high in sboor and silver bar from the first week onwards, whilst the concentration of fat, protein and ash decreased (Table 3). The quantity of slime was low in gattan which agrees with higher concentrations of fat, protein and ash. This indicates that silver bar and sboor started spoiling more quickly than bunni, pomfret and gattan. TVN results also suggest that the silver bar and sboor spoiled more quickly than the other species.

### *Contamination*

The results of fluorescence studies to establish contaminants in the fish are shown in Table 4. Bunni, shabout, grey pomfret, jewfish, silver bar, jewelled shad, hamam and shanak gave negative results.

TABLE 4. *Identification of hydrocarbons*

| *Name of fish* | *Fractions* | *Fluorescence** |
|---|---|---|
| Gattan | 1 (elution by di-ethyl ether) | pale blue |
| | 2 (elution by chloroform) | pale blue |
| | 3 (elution by methanol) | pale blue |
| Sboor | 1 (elution by di-ethyl ether) | pale blue |
| | 2 (elution by chloroform) | pale blue |
| | 3 (elution by methanol) | pale yellow |

* Pale yellow indicates crude oil; pale blue indicates other oils.

The results indicate that only gattan and sboor were contaminated with hydrocarbons. The chemical detection of contaminants in these fish was corroborated by organoleptic testing. Fresh fish samples were prepared and cooked for tasting. An intolerable kerosene-like smell was observed in these fish and they were considered unfit for consumption.

These observations suggest areas for further study. Attention should be given to investigating the source of these contaminants in the body of the fish, the mechanism of their distribution and interaction within the body and the method by which these can be eliminated.

There are two contradictory views concerning the purging of contaminants. Blumer and Saas (1972) indicated that after contamination the petroleum hydrocarbons might persist throughout the life of fish whereas Vaughan (1973) found that keeping contaminated fish in clear water for a period of three to seven weeks, or even less, was sufficient to purge out all detectable levels of hydrocarbons from the fish tissues. Co-ordinated efforts and studies are needed on this subject to establish the correct nature and the limit of tolerance of these products which may cause great damage to biological systems.

## Conclusion

On the basis of this preliminary study, further work needs to be carried out on the composition of the important fish in this area. This knowledge is needed primarily to improve the methods of utilization, preservation, storage and marketing and for the formulation of new products for human consumption.

Some fish species in the region either become unfit for human consumption due to petroleum contamination or are killed by crude oil. This represents a wastage of natural resources. A detailed study is necessary to find out ways and means of eliminating the pollutants. It should also include a study on the nature of tar balls disposed of by merchantile vessels in the sea.

## Acknowledgements

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## References

**Association of Official Agricultural Chemists** (1965) *Official methods of analysis,* 10th edn, Washington, DC: AOAC, 957 pp.

**Blumer, M. & Saas, J.** (1972) *WHOI Tech. Rep.* No 72. Massachusetts: Woods Hole Oceanographic Institution.

**Burgess, G. H. O., Cutting, C. L., Lovern, J. A. & Waterman, J. J.** (1967) *Fish handling and processing.* Edinburgh: HMSO, 390 pp.

**Council of Scientific and Industrial Research** (1962) *The wealth of India: raw materials.* Vol. IV (Supplement) New Dehli: CSIR, 100 pp.

**Halstead, B. W.** (1972) Toxicity of marine organisms caused by pollutants. In: *Marine pollution and sea life* (ed M. Ruivo) pp 584–594. Surrey: Fishing News (Books) for FAO.

**Khawaja, D. K. & Jafri, A. K.** (1967) Biochemical changes in the muscle of the freshwater murrel, *Ophicephalus punctatus. Broteria,* **36**, 71–94.

**Love, R. M.** (1970) *The chemical biology of fishes.* New York: Academic Press, 547 pp.

**Natrajan, M. V. & Sreenivasan, A.** (1961) *Indian J. Fish.*, **8**, 422.

**Neuhaus, O. W. & Halver, J. E.** (1969) *Fish in research.* New York: Academic Press, 311 pp.

**Paniaotova, M. & Bailozov, D.** (1960) *Nauchi Trudov Bulgarska Akademiya Nauk,* **2**, 113.

**Pawar, S. S. & Magar, N. G.** (1965) Biochemical changes in catfish, *Tilapia* and mrigal fish during *rigor mortis. J. Food Sci.,* **30**, 121–125.

**Pearson, D.** (1970) *The chemical analysis of foods,* 6th edn. London: J. & A. Churchill, 604 pp.

**Sullivan, B.** (1974) Marine pollution by carcinogenic hydrocarbons. In: *Marine pollution monitoring (petroleum).* Proceedings of a symposium and workshop, Gaithersburg, USA, May 1974. USA: National Bureau of Standards Special Publication No 409.

**Tomlison, N., Arnold, E. S., Roberts, E. & Geiger, S. E.** (1961) Observations on *post mortem* biochemical changes in fish muscle in relation to *rigor mortis. J. Fish. Res. Board Can.* **18**, 321–336.

**Warner, J. S.** (1974) Quantitative determination of hydrocarbons in marine organisms. In: *Marine pollution monitoring (petroleum).* Proc. symp. workshop, Gaithersburg, USA, May 1974. USA: National Bureau of Standards Special Publication No 409.

**Wiechers, S. G. & Dreosti, C. M.** *(1970)* The chemical composition of South African fishes. In: *The chemical biology of fishes* (ed R. M. Love) New York: Academic Press, 547 pp.

# Mercury content in the main marine species in Uruguay*

**S. Mattos A. and E. Torrejon S.**
Laboratorio Technológico del Uruguay, Uruguay

## Summary

The main species of commercial interest for export were analysed. The total mercury content was determined applying the wet-acid digestion method. The readings were obtained through an atomic absorption spectrophotometer Perkin Elmer 306. The paper provides a detailed description of the technique employed and includes a study of the mercury content variations according to size of the principal species, *Merluccius merluccius hubbsi,* because of its relevance for the fishing industry in Uruguay.

## Résumé

Les principales espèces d'intérêt commercial pour l'exportation ont été analysées. La quantité totale de mercure a été déterminée par la méthode de digestion par l'acide en milieu humide. Les mesures ont été effectuées au spectrophotomètre d'absorption atomique Perkin Elmer 306. L'article donne une description détaillée de la technique utilisée et comporte une étude des variations de la quantité de mercure selon la taille de l'espèce principale, *Merluccius merluccius hubbsi*, à cause de son importance pour l'industrie du poisson en Uruguay.

## Resumen

Se realizó un estudio sobre las especies de mayor importancia destinadas a la exportación. Para la determinación de mercurio total, se utilizó el método de digestión por via húmeda ácida, realizando las lecturas con espectrofotómetro de absorción atómica Perkin Elmer 306. Se detalla en el documento la técnica empleada y se incluye además un estudio sobre la especie de mayor significación, *Merluccius merluccius hubbsi*, y la variación del contenido de mercurio en función del tamano.

## Introduction

Sanitary authorities in many countries are paying particular attention to the presence of mercury in foodstuffs, especially in fish.

The use of mercury and its compounds in industry and agriculture is often given as the source of pollution, particularly of the aquatic environment. In many cases, however, museum samples caught almost a century ago show mercury levels reaching the maximum values found in certain species nowadays (Miller *et al.*, 1972). Therefore, it is doubtful whether the presence of mercury in fish is due, in every case, to the effects of pollution caused by human activities. On the other hand, the other components of the human diet also show considerable levels of mercury; therefore, the real importance of this contaminant in fish depends on the amount eaten in relation to the other dietary components.

The purpose of this study was to provide information on the actual levels of mercury in the main marine species caught in the Atlantic Ocean near the coast of Uruguay. Special attention was paid to the species *Merluccius merluccius hubbsi,* the most important species due to its world-wide demand. The relationship between mercury levels and size of fish was studied. It was proved that these two variables are directly related. The maximum values found are definitely below the generally accepted limits. The other species studied showed similar mercury levels and in tuna the values were similar to those found elsewhere.

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* A Spanish translation of this paper is available from the Tropical Products Institute.

Total mercury was determined by atomic absorption spectrophotometry using the Hatch and Ott (1968) flameless method. A Perkin Elmer spectrophotometer Model 306 with a mercury analysis system was employed. The technique used was based on the acid digestion of the sample, the oxidation of mercury compounds and their reduction to metallic mercury which is carried, as a vapour, by an air current to the cell of the measuring system.

The method is based on the technique employed by Piratti *et al.* (1971) with some simplifications.

### *Equipment*

Perkin Elmer atomic absorption spectrophotometer 306, equipped with hollow cathode mercury lamp and registrator.

Perkin Elmer mercury analysis system consisting of: air pump, aerator, cell 15 cm long with quartz windows.

Water-vapour condensation trap, instead of a magnesium perclorate desiccant.

Digestion and aerator flask, 100 cm³ capacity, long neck with ground glass seal 24/40.

Air refrigerants adjustable to the digestion flasks.

Water bath with thermostat.

### *Reagents*

All products should be pure for analysis.

(a) Sulphuric acid, sp gr: 1.84
(b) Nitric acid, sp gr: 1.40
(c) Potassium permanganate solution 5% w/v
(d) Hydroxylamine hydrochloride solution 10% w/v
(e) Stannous chloride solution 10% w/v
    Dissolve 25 g of $SnCl_2.2H_2O$ in 50 cm³ of concentrated hydrochloric acid and make up to 250 cm³ with distilled water. Keep in glass bottle with granulated pure tin.
(f) Solution of sodium chloride 7.5% w/v
(g) Standard mercury solution of 100 μg/cm³. Dissolve 1.354 g of pure $Hg\ Cl_2$ and make up to 1,000 cm³ with sulphuric acid 0.1N.
    By means of consecutive dilutions in 1N $H_2SO_4$, obtain a calibration solution of 0.1 μg/cm³. This must be prepared just before use.

### *Preparation of the sample*

Grind up 50–100 g of fish tissue. Weigh a sample of 0.5 to 1.0 g and transfer to a digestion flask. Add sulphonitric mixture (1 : 1). Fix the air refrigerant and place the flask and content on a water bath at 70–72°C for two hours. Cool with water and stir in 10 cm³ of potassium permanganate solution. Allow to stand for no less than 30 minutes, stirring the contents of the flask several times. During this stage, mercury oxidation will be completed and nitrous vapours eliminated. These vapours interfere with the spectrophotometric reading (Hoover *et al.*, 1971). Add 5 cm³ of the hydroxylamine hydrochloride solution, stir to eliminate permanganate excess and when decolourized add 10 cm³ of the sodium chloride.

The instrument should be stabilized by circulating air in 35 cm³ of distilled water in a digestion flask. Add 5 cm³ of stannous chloride solution to the prepared sample and couple the aerator immediately thus obtaining the peak absorbance. The aerator should only be removed after the signal drops back to the base line of the register.

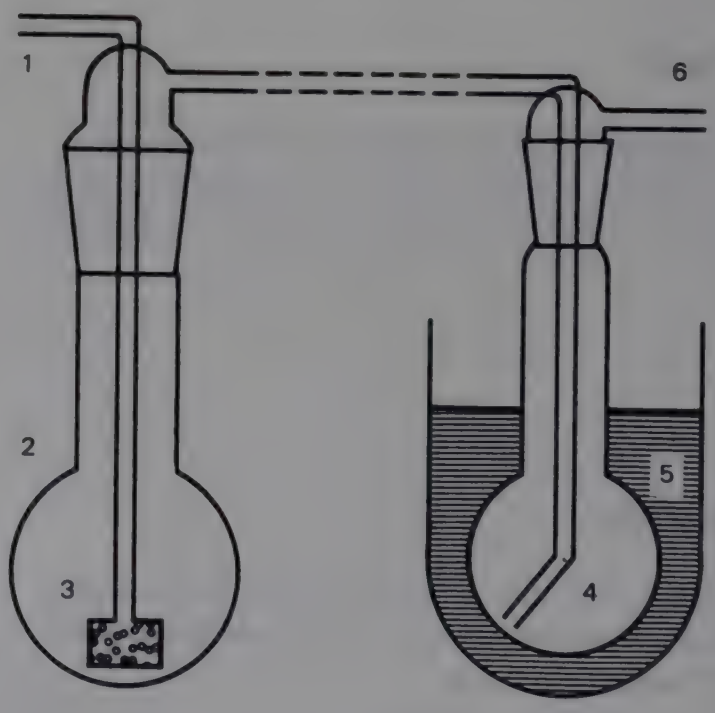
Prepare a reagent blank and treat as for the sample. The average value of the reagent blank during this study was 0.01 μg of mercury.

### *Calibrating*

Standards for the calibration curve are made in triplicate; 0, 0.5, 1.0, 3.0, 5.0 and 7.0 cm³ of the standard solution of 0.1 μg/cm³ of mercury are placed in the digestion flasks. Add 5 cm³ of the sulphonitric mixture, cool to room temperature and add 10 cm³ of permanganate solution and then follow as in the sample. Plot a calibration curve of mercury against absorbance, deducting the value obtained for the reagent blank.

In this study the calibration curve was linear up to 0.8 μg. When the 0.8 μg figure is exceeded, a convenient aliquot of the prepared sample is diluted to an established volume (50 or 100 cm³) with distilled water.

**Figure 1**
**Aerator and steam trap**



1. Air inlet
2. Digestion flask
3. Aerator
4. Stem condensation trap
5. Ice bath
6. Air outlet

### *Experimental*

Figure 1 shows the aerator installation employed. As mentioned before, the desiccant of the Perkin Elmer

TABLE 1. *Mercury levels in 'merluza'*, Merluccius merluccius hubbsi, *(hake)*

| *Whole fish weight (kg)* | *Number of samples* | *Minimum value (ppm)* | *Maximum value (ppm)* | *Mean value (ppm)* |
|---|---|---|---|---|
| 0.5–1.0 | 18 | 0.005 | 0.025 | 0.015 |
| 1.0–1.5 | 21 | 0.015 | 0.09 | 0.06 |
| 1.5–2.0 | 22 | 0.02 | 0.11 | 0.06 |
| 2.0–2.5 | 25 | 0.04 | 0.12 | 0.07 |
| 2.5–3.0 | 27 | 0.06 | 0.16 | 0.09 |

TABLE 2. *Mercury levels in other species*

| *Common name in Uruguay* | *Scientific name* | *Number of samples* | *Minimum value (ppm)* | *Maximum value (ppm)* |
|---|---|---|---|---|
| Corvina | *Micropogon opercularis* | 18 | 0.03 | 0.15 |
| Pescadilla | *Cynoscion striatus* | 17 | 0.005 | 0.07 |
| Palometa | *Parona signata* | 6 | 0.13 | 0.28 |
| Mochuelo | *Tachysurus barbus* | 4 | 0.02 | 0.06 |
| Anchoíta | *Engraulis anchoita* | 16 | 0.005 | 0.01 |
| Sábalo | *Prochilodus platensis* | 5 | 0.01 | 0.025 |
| Gatuso | *Mustelus schmitti* | 17 | 0.09 | 0.32 |
| Atún ojo grande | *Thunnus obesus* | 13 | 0.40 | 1.80 |
| Atún albacora | *Thunnus alalunga* | 12 | 0.26 | 1.15 |

mercury analysis system was replaced by a water-vapour condensation trap. This was used to overcome the problems incurred from the layer of magnesium perchlorate, which rapidly compacts in the tube and obstructs the air flow, thus reducing the sensitivity and reproducibility of the readings.

The operation was simplified using the same digestion flask in the system thereby avoiding transfers and losses.

The spectrophotometer was operated according to the following instrumental conditions:

Lamp intensity: 6mA
Wave-length: 253.7 nm
Slit width: 4 (0.7 nm)
Scale expansion: 3 x
Air flow: 3000 cm$^3$/min

## Results

Table 1 shows the mercury levels found in 'merluza', *Merluccius merluccius hubbsi,* (hake). Even for big fish (2.5–3.0 kg) the contamination level is definitely below the acceptable limits.

A similar conclusion may be reached from the information obtained for the remaining species (see Table 2). The species of tunids analysed show mercury values similar to those found in other studies, particularly that made by Pirati *et al.* (1971 and 1972).

## References

**Hatch, W. R. & Ott, W. L.** (1968) Determination of submicrogram quantities of mercury by atomic absorption spectrophotometry. *Anal. Chem.* **40** (14), 2085–2087.

**Hoover, W. L., Melton, J. R. & Howard, P. A.** (1971) Metals and other elements: determination of trace amounts of mercury in foods by flameless atomic absorption. *J. Assoc. Off. Anal. Chem.* **54**, 860–865.

**Miller, G. E., Grant, P. M., Kishore, R., Steinkruger, F. J., Rowland, F. S. & Guinn, V. P.** (1972) Mercury concentrations in museum specimens of tuna and swordfish. *Science,* **175**, 1121–1122.

**Pirati, D., Pirazzoli, P., Gheradi, S. & Guidi, G.** (1971) *Industria Conserve,* **45**, 258.

**Ibid** (1972) ibid i, 11.

# Handling fish in Ghana

**Lydia A. Bonsu**
Food Research Institute, Ghana

## Summary

The paper examines handling methods at sea and ashore in relation to three levels of fishing in Ghana. Deterioration in fish quality is attributed to prolonged exposure of fresh fish to high ambient temperatures (26 – 34°C) during handling at sea, sale ashore (involving a series of agents) and during transportation to processing sites. It is suggested that proper use of ice at all stages of handling will preserve the initial quality of fish. The need for research, inspection and quality control of fresh and frozen fish is expressed.

## Résumé

L'article examine les méthodes de manipulation en mer et à terre en ce qui concerne trois types de pêche au Ghana. La détérioration de la qualité du poisson a été attribuée à une exposition prolongée du poisson frais à des températures ambiantes élevées (26 –34°C) au cours de sa manipulation en mer, pendant la vente à quai (ceci impliquant une série de facteurs) et au cours du transport jusqu'aux lieux de préparation. On a suggéré que l'utilisation convenable de glace à tous les stades de la manipulation permetrait de conserver la qualité initiale du poisson. Il est question également de la nécessité de l'inspection et du contrôle de qualité du poisson frais et du poisson congelé.

## Resumen

El informe examina los métodos de manipulación en el mar y en tierra relativos a tres etapas del manejo del pescado en Ghana. La deteriorización de la calidad del pescado se atribuye a la larga exposición del pescado fresco a las altas temperaturas del medio ambiente (26–34°C), durante la manipulación en el mar, durante la venta en tierra (incluyendo una serie de agentes) y durante el transporte a los lugares de procesamiento. Se sugiere que con un uso adecuado del hielo, en todas las etapas de la manipulación, se conseguiría mantener la calidad inicial del pescado. También se expresa la necesidad de una inspección y control de calidad del pescado fresco y congelado.

## Introduction

With a population of about nine million and fish production in the region of 360,000 tonnes in 1972 (the most recent data available, see Table 1), Ghana is one of the developing countries with a high demand for fish. In 1972 the local fishing industry supplied about 78% of the demand while the remaining 22% was imported in the form of frozen fish and fish products.

In an effort to meet the local demand for fish, the Government of Ghana encouraged the expansion and development of the fishing industry with the result that emphasis shifted from rural marine fisheries in the 1950's to deep-sea fisheries in the 1960's. This has created three levels of fishing: canoes, inshore motor vessels and deep-sea trawlers.

Fish handling operations on these fishing vessels and ashore have generally lagged behind the rate of expansion and development of the industry. Consequently, there is wastage of fish through spoilage. The purpose of this paper is to examine handling practices in relation to the three levels of fishing and to suggest improvements on existing practices to reduce fish spoilage. The scope of the paper is confined to marine fish.

## Handling at sea

### *Canoes*

The canoe is the traditional fishing craft in Ghana. It is less than 10m (30ft) long and has no facility for carrying

TABLE 1. *Fish production from 1963 to 1972 (tonnes)*

| *Source of Fish* | *1963* | *1964* | *1965* | *1966* | *1967* | *1968* | *1969* | *1970* | *1971* | *1972* |
|---|---|---|---|---|---|---|---|---|---|---|
| Canoes | 36,354 | 43,322 | 16,919 | 25,222 | 39,874 | 33,310 | 60,198 | 89,958 | 113,263 | 153,691 |
| Inshore motor vessels | 2,493 | 29,975 | 49,740 | 49,345 | 24,568 | 12,458 | 19,330 | 20,192 | 19,051 | 30,081 |
| Deep-sea trawlers | 9,602 | 15,961 | 34,233 | 25,298 | 27,546 | 23,019 | 37,097 | 47,438 | 43,940 | 65,295 |
| Inland fishery | 250 | 62 | 13,370 | 600 | 2,994 | 7,915 | 22,723 | 39,903 | 39,217 | 32,389 |
| Total domestic production | 48,699 | 66,923 | 114,262 | 100,465 | 94,982 | 76,702 | 139,348 | 197,491 | 215,471 | 281,456 |
| Fish, in transit, sold locally | – | – | – | – | 1,320 | 2,750 | 708 | 473 | 361 | 332 |
| Total imports | 35,362 | 30,940 | 29,458 | 43,705 | 17,511 | 30,718 | 18,700 | 46,764 | 51,815 | 76,758 |
| Total | 84,061 | 67,863 | 143,720 | 144,170 | 113,813 | 110,170 | 158,756 | 244,728 | 267,647 | 358,546 |

Source: Fisheries Department, Ministry of Agriculture.

TABLE 2. *Inshore motor fishing vessels from 1963 to 1972*

| *Length of vessel* | | *1963* | *1964* | *1965* | *1966* | *1967* | *1968* | *1969* | *1970* | *1971* | *1972* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *(m)* | *(ft)* | | | | | | | | | | |
| ≤ 10.6 | ≤ 32 | 183 | 129 | 182 | 223 | 228 | 154 | 145 | 201 | 200 | 168 |
| 11–20 | 33–60 | 50 | 44 | 66 | 92 | 107 | 111 | 128 | 131 | 119 | 95 |
| 20–33 | 61–100 | 18 | 19 | 40 | 39 | 39 | 21 | 29 | 28 | 27 | 21 |

Source: Fisheries Department, Ministry of Agriculture.

ice to sea. Most canoes are fitted with outboard motors but a few, which operate close to the beach, use paddles.

The canoe fishermen go to sea at dawn or in the evening when temperatures are fairly low so that the catch is protected from the sun. When caught, the fish are put into the bottom of the canoe and sorted roughly into species. Since there is no special compartment for the fish, the crew walk on them causing crushing and bruising which accelerates spoilage. When the catch is heavy the gut contents of the lower fish, especially sardines, herrings and small mackerel, are squeezed out and infect the external surfaces. The catch is usually landed less than six hours after harvesting and, apart from bruising and crushing, the quality of the fish is usually good.

### *Inshore motor vessels*

Inshore motor vessels operating in Ghana range from 10m (30ft) to 33m (100ft) in length. Vessels less than 20m (60ft) long have no facilities for carrying ice to sea but the larger vessels have fish holds equipped with deck-head cooling grids. Table 2 shows the numbers of these vessels between 1963 and 1972; it is evident that there are more vessels without any facilities for carrying ice and this trend has not changed over the years.

Inshore motor vessels stay at sea for one to five days depending upon their size. When a catch is made, it is hauled onto the deck, sorted roughly into species and then shovelled into the fish holds, where it is stored in bulk with or without ice depending on the facilities on the vessel. The bulk stowage causes bruising and crushing of the lower fish and, where the fish are un-iced, the centre of the pile increases in temperature, thus causing spoilage. Even where icing facilities exist on board, the catch may be of poor quality because ice has not been taken to sea or insufficient ice has been used.

Three factors have contributed to the inadequate use of ice on inshore vessels. These factors are the inadequate supply, the high prices and the poor quality of ice.

*Inadequate supply of ice:* Almost all the ice-producing companies are situated at the main fishing harbour at Tema where 75% of the vessels berth. Thus, 25% of the vessels have no access to ice. Even at Tema, the biggest company producing ice for inshore vessels has only two plants with capacities of 44 tonnes of flake ice and 40 tonnes of crushed ice per day. With frequent machinery breakdowns and lack of spare parts for maintenance, the company is unable to operate at full capacity and, therefore, is incapable of satisfying the demand.

*High prices of ice:* The selling price of one tonne of flake ice is twelve cedis (₵12.00*, which is approximately six pounds £6.00), and that of block ice is eighty pesewas (80p), or forty pence (£0.40), per block. Assuming 2kg of flake ice is used to ice 1kg of fish, it will cost ₵24.00 to ice one tonne of fish and this is an appreciable cost on production. Since the demand for fish is high and the selling price does not depend on the quality, owners of inshore vessels do not usually see the justification for adding the extra cost of ice to production costs.

*Poor quality of ice:* The quality of block ice is poor. The block is usually opaque and has numerous air gaps. There have been occasions when a private company produced block ice which had holes through the centre. Investigations showed that the freezing process was slow with the result that the centre of the block was not frozen.

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* 1 Cedi (₵) = £0.51, at June 1976.

Crushed ice from such a block melts quickly and does not last throughout the fishing trip.

Flake ice, produced by a state-owned company, is of good quality but the ice is transported to the vessels in open wooden trucks without any protection from the sun. This exposure accelerates melting and wastage of ice before it is put to use.

### *Deep-sea trawlers*

All the deep-sea trawlers operating in Ghana have facilities for freezing and cold storage of fish. The catch is sorted into species with no regard to size and then arranged in metal trays with average capacities of 20kg (44lb) or 30kg (66lb) of fish. The trays are then conveyed on a trolley into a blast freezer where the fish are frozen for about 6 hours. While this operation is carried out, the remaining fish are exposed and the quality deteriorates. These fish are not discarded but frozen and mixed with good quality fish.

After freezing, the fish are packed into paper cartons and conveyed to fish holds at –20°C. During storage in the holds, the fish dehydrate and lose weight because the carton used in packaging is not a good moisture barrier. In the early 1960's, attempts were made to overcome the problem of dehydration by lining the carton with a plastic film. This precaution has been stopped due to unavailability of the film on the local market.

## Handling ashore

### *Fish from canoes*

*Discharging:* The fish are scooped up into medium-sized plastic buckets and emptied into basins which are regarded as the unit measure in the sale of fish. About three buckets of fish make a basin which may contain from 100 to 500 fish depending on their size.

*Sale of fish:* After unloading the catch, the leader of the crew bargains for the price of each basinful of fish with an agent, who is usually the wife or relative of the canoe owner or a share holder in the business. Subsequent transfers are by similar bargaining before the fish eventually reach the processor. This method of selling fish may take up to three or more hours, during which the fish are exposed to the sun and the wind. Since the fish are not iced, quality deterioration occurs before the end of the sales.

### *Fish from inshore vessels*

*Discharging:* The fish are unloaded from the holds by shovelling into plastic buckets. Each bucket of fish is then passed along a line of crewmen to the quayside where the contents are emptied into wooden fish boxes which have a capacity of about 30kg. Each member of the crew takes one or two fish from the bucket as payment for services rendered.

When all the fish have been off-loaded, the boxes are arranged in piles of five in the sun for purposes of counting. This method of unloading the catch by hand takes up to four hours during which the temperature of the fish increases considerably even if they have been iced at sea. Table 3 shows landing temperatures of 100 boxes of iced fish.

TABLE 3. *Temperatures of 100 boxes of iced fish immediately after unloading the holds of an inshore vessel at Tema Fishing Harbour*

| *Temperature range (°C)* | *% of boxes at temperature* | |
|---|---|---|
| | *Top of box* | *Middle of box* |
| 0 – 5 | 14 | 20 |
| 6 – 15 | 69 | 63 |
| 16 – 27 | 17 | 17 |

Source: Trenning, 1969.

Those boxes in which the temperature had risen to above 15°C, were among the first to be loaded with fish. Iced fish in these boxes had warmed up to almost ambient temperature by the end of the discharging operation but, in the boxes which were among the last to be loaded with fish, the temperatures were between 0 and 5°C. These observations show that the manual unloading process and exposure cause a rise in the temperature of the iced fish. Since the spoilage rate of fresh fish doubles for every six degrees rise in temperature, the fish which were unloaded first from the holds would spoil very quickly and the efforts made to keep the fish cool at sea would be wasted by the slow unloading process.

*Sale of fish:* The sale of fish from inshore vessels if very similar to that for canoe caught fish. The exceptions are that the vessel owner conducts the sale and the agents are not usually related to the vessel owner.

### *Fish from deep-sea trawlers*

*Discharging:* The cartons of fish are discharged mechanically by cranes into wooden trucks and transported to cold rooms at –10°C. During the discharging operation, the frozen fish increase in temperature and the cartons become wet with drippings from the fish. Tables 4a and b show the temperatures of frozen fish at the time of unloading from the holds of two trawlers on several occasions during 1971 and 1972. The fish were supposed to be at –20°C but, due to the high ambient temperature at the time of unloading, none of the fish was at this temperature. The average temperature of fish from vessel A was a few degrees below –10°C, the temperature of the cold room in which the fish would be stored on land. On two occasions in April 1971, fish with temperatures above –10°C were unloaded from vessel B. These fish, when stored in the cold room, would slowly equilibrate with the cold room temperature and it is likely that textural deterioration would occur.

*Sale of frozen fish:* Until quite recently, frozen fish used to be sold through a passbook system. The fish were allocated to the passbook holder at fixed prices and she usually sold her fish to the processor and retailer. Recently, the Government banned the passbook system and frozen fish is now sold directly to the processor and retailer.

TABLE 4a. *Temperatures of frozen fish (stored at −20°C on board) during discharge*
*(a) From vessel A, November 1971 – November 1972*

| Temperature (−°C) | | No. of fish examined |
|---|---|---|
| Average | Range | |
| 15 | 14 – 15 | 10 |
| 17 | 15 – 18 | 30 |
| 16 | 14 – 18 | 20 |
| 16 | 14 – 18 | 30 |
| 15 | 14 – 17 | 30 |
| 13 | 10 – 15 | 30 |
| 13 | 12 – 15 | 20 |
| 14 | 12 – 15 | 10 |
| 15 | 13 – 17 | 30 |
| 14 | 12 – 16 | 20 |
| 15 | 14 – 17 | 30 |

Source: Fisheries Department, Tema (Ministry of Agriculture)

TABLE 4b. *Temperatures of frozen fish (stored at −20°C on board) during discharge*
*(b) From vessel B, April 1971 – March 1972*

| Temperature (−°C) | | No. of fish examined |
|---|---|---|
| Average | Range | |
| 13 | 10 – 16 | 30 |
| 8 | 5 – 10 | 30 |
| 4 | 2 – 8 | 24 |
| 13 | 12 – 14 | 20 |
| 13 | 12 – 14 | 10 |
| 13 | 12 – 15 | 20 |
| 13 | 13 – 14 | 10 |
| 15 | 14 – 15 | 10 |
| 14 | 12 – 15 | 30 |
| 13 | 10 – 15 | 30 |
| 14 | 13 – 17 | 30 |
| 13 | 10 – 16 | 30 |
| 13 | 10 – 16 | 30 |
| 13 | 12 – 15 | 20 |

Source: Fisheries Department, Tema (Ministry of Agriculture)

## Processing and distribution

The majority of fresh fish purchased from canoes and inshore vessels are processed at the coast before distribution inland. Most of the processing sites are close to the landing sites but, during the lean fishing season, the processors travel distances of about 32km (20 miles) to purchase fresh fish. They depend on public transport which is unreliable. Processors in the same locality may hire a lorry to convey the fish but, when this fails, they stand by the road side for hours in an attempt to get a lorry. Further exposure of the fish in this way accelerates spoilage.

At the processing sites, the fish are washed and scaled. They may also be gutted if they are intended for salting and sun drying: fish intended for smoking are not gutted. A small proportion of fresh fish from inshore vessels may be frozen and cold stored especially during the glut season. Fish are also sold in the fresh state without ice; these spoil quickly due to exposure at high ambient temperatures.

## Recommendations

Attempts are being made at Government level to improve and develop fishing techniques but very little is being done to improve handling practices even for the sophisticated fishing craft ie the deep-sea trawlers. Possible ways of improving handling practices, on each type of fishing vessel, are indicated below.

### *Handling at sea*

*Canoes and small inshore vessels less than 20m (60ft) in length:* These craft have no facilities for carrying ice but they could use insulated boxes to carry ice to sea. The fish can be packed into these boxes and 'top iced'. Boxing the catch will prevent crushing and bruising which occurs with the present system.

*Large inshore vessels more than 20m (60ft) in length:* The vessels should make full use of their facilities for carrying ice to sea. The fish can be boxed and 'top iced' as indicated above and the vessel owners should be encouraged to take sufficient ice to sea.

*Deep-sea trawlers.* Fish caught by the deep-sea trawlers are frozen and stored for about six months. Therefore, special care in handling is necessary to ensure that the initial quality, before freezing, is good. To maintain the initial quality during handling, the fish must be chilled and protected from the sun. Chilling can be done by submerging the fish in refrigerated potable sea water. As an alternative, a small flake ice machine can be carried on the trawler and ice can be made from potable sea water.

Fish, which have spoiled before freezing, should be sorted out and frozen separately; these fish can be used for fish meal.

The paper carton used for packaging frozen fish is unsuitable since it permits dehydration and has poor water-repellent properties. A more suitable material is waxed carton but, in the absence of this material, the cartons used presently should be lined with a suitable film such as cellophane.

### *Handling ashore*

*Canoes and inshore vessels:* The discharging operations on inshore vessels should be mechanized to speed up the operation; the present manual method contributes greatly to the spoilage of fish at the quayside.

The sale of fish by bargaining should be discouraged and sale by contract introduced. Contract sale has the advantage of not being time consuming and, therefore, the fish are not exposed to the sun for long periods. In 1972, when there was a bumper catch of fish, the Government entered into an experimental contract sale with 45 inshore vessels at Tema. The Government was to supply ice at a reduced price to these vessels and would purchase fish at prices fixed according to the species. The experiment was unsuccessful because the Government could not meet the demand for ice and the vessel owners were not prepared to accept prices other than the guaranteed price although the fish landed were mostly of very poor quality (Amu, 1973). Having learnt from the 1972 experience, the experiment can be repeated with goods results.

*Deep-sea trawlers:* Insulated vans should be used to convey frozen fish from the vessels to the cold room; this will check temperature rise in the product.

### *Processing and distribution*

The application of ice to the fish before processing and during distribution should be encouraged in order to reduce spoilage. To overcome transportation difficulties, the fish processors should be encouraged to purchase lorries through their co-operative associations. This will help a great deal to reduce spoilage.

### *Ice-making facilities*

Before the use of ice in the fishing industry is encouraged, there must be a reliable supply of ice. The largest company, which supplies ice to the fishing industry, cannot meet the demand for ice due to frequent breakdown of the machinery. Since the breakdowns are due to the old age of the machines and lack of spare parts to maintain them, new machines should be installed and spare parts should be made available for regular maintenance. Also the number of commercial ice plants should be increased so that each fishing harbour and landing site has a plant; this will help reduce the price of ice. The quality of ice, especially block ice, can be improved by quick freezing with a refrigerant at a very low temperature. Also, flake ice should be transported in insulated vans to the fishing vessels to prevent melting.

### *Fish inspection and quality control*

There is no fish inspection and quality control at the quayside. Therefore, fish of any quality are sold to the processor who has to find some use for them. A system of fish inspection and quality control should be introduced to ensure that fish unfit for human consumption are discarded or used for fish meal.

### *Research*

There is room for research into handling with a view to improving current methods. Although ice is being used in the fishing industry, the benefits derived from this method of preservation have not been studied in great detail for Ghanaian fish, and tropical fish in general. Research in this respect is therefore essential. The Food Research Institute embarked upon research into handling methods but, since its fish preservation section is limited in personnel, work has not progressed as expected.

## References

**Amu, L.** (1973) *A report on bulk purchase of fish during 1972 herring season.* Accra, Ghana: Food Research Institute. 10 pp.

**Anon.** 1973 *The Ghana fishing industry.* Tema, Ghana: Fisheries Research Unit.

**Fisheries Department, Ministry of Agriculture, Ghana.** 1965–1972 Annual Reports.

**Trenning, A.** (1969) *Tema Fishing Harbour.* Accra, Ghana: Food Research and Development Unit.

**Waterman J.** (1965) Handling fish at sea and ashore. In: *Fish handling and preservation.* Proceedings at meeting on Fish Technology, Scheveningen, September 1964. Paris: Organisation for Economic Co-operation and Development.

# A new system for boxing iced fish in the tropics

**F. Anthonsen, Thyra Bjergskov and P. Hansen**
Ministry of Fisheries, Denmark

## Summary

In many developing countries, coastal fisheries are very important and account for the greater part of fish landings. Present developments are concentrated on the replacement of dug-out canoes, rafts, catamarans and other very small vessels by small motorized vessels which cover greater areas and land more fish. The preservation of these catches on board and during distribution ashore presents great problems under tropical conditions. The simplest and most desirable solution is the chilling of these catches with ice. Ice is very expensive, however, and much ice would be lost if stored by any traditional method prior to its use for fish packing on board the fishing vessels.

The paper describes a new boxing system in which the loading of ice into the boxes is undertaken at the ice plant ashore. Each box holds an even layer of ice and the boxes are stacked in a nesting position and insulated in such a way that the loss of ice during the outward journey to the fishing grounds is reduced to a minimum, even in warm climates. The design of such boxes and their accommodation on board small coastal vessels are discussed.

## Résumé

Dans de nombreux pays en voie de développement, les pêches côtières sont très importantes et représentent la plus grande part de la quantité de poisson pêchée. On s'efforce actuellement de remplacer les pirogues, radeaux, catamarans et autres très petits bateaux par de petits bateaux à moteur qui opèrent sur des zones plus étenduss et débarquent davantage de poisson. La conservation des produits de la pêche à bord et au cours de la distribution à terre pose d'importants problèmes sous les climats tropicaux. La solution la plus simple et la plus souhaitable est la réfrigération des produits de la pêche pa la glace. Cependant la glace est très chère et une importante quantité de glace serait perdue si elle était stockée par des méthodes traditionnelles avant son utilisation pour la conservation du poisson à bord des bateaux de pêche.

Cet article décrit un nouveau procédé de conditionnement dans lequel la répartition de la glace dans les caisses est entreprise à quai dans une usine de fabrication de glace. Dans chaque caisse, est une couche uniforme de glace et les caisses sont empilées et isolées de telle sorte que la perte de glace pendant le voyage jusqu'aux ports de pêche est réduite au minimum, même dans les climats chauds. Les caractéristiques de ces caisses et de leur installation à bord des petites embarcations côtières sont étudiées.

## Resumen

En muchos países en vías de desarrollo las pesquerías costeras son muy importantes y proporcionan la mayor parte de la producción pesquera. El desarrollo actual se basa en la sustitución de canoas, balsas, catamaranes y otras pequeñas embarcaciones por pequeñas embarcaciones motorizadas que cubren zonas más amplicas y recogen más pesca. La conservación del pescado a bordo y durante la distribución en tierra presenta graves problemas bajo condiciones tropicales. La solución más simple y deseable es la refrigeración del pescado con hielo. Sin embargo el hielo es muy caro, y se desperdiciaría mucho almacenándolo por cualquier método tradicional antes de usarlo para el envasado del pescado a bordo de las embarcaciones pesqueras.

El artículo describe un nuevo sistema de empaquetado en cajas, en el cual la dosificación del hielo se realiza en la fábrica de hielo en tierra. Cada caja contiene una capa de hielo contínua, y se apilan en forma compactada y aislada, de modo que la pérdida de hielo durante el viaje de salida hasta la zona de pesca se reduce a un mínimo, incluso en los climas cálidos. Se discute el diseño de estas cajas y su colocación a bordo de las pequeñas embarcaciones costeras.

## Introduction

While great efforts have been made in the development of deep-sea fisheries in recent years, little attention has been given to coastal fisheries although, on a world basis, a greater number of fishermen are engaged in these fisheries. Millions of small coastal vessels still operate without the facilities required for good handling of the catches. When means to protect the catch against the heat of the sun and the wind are missing, fish start deteriorating rapidly during the stowage on board thus limiting quality and storage life after landing. The lack of facilities to stow and chill the catches properly on board results in wastage of fish and limits the development of these coastal fisheries.

Larger vessels, with separate fish holds under the deck, often rely on ice chilling of catches for maintaining quality and storage life. It has often been stated, however, that small open vessels do not have room for icing the catch on board. For this reason, such vessels are often exempt from the regulations requiring chilling of catches intended for human consumption. Among the technical difficulties involved in introducing ice chilling on board small open vessels are those of protecting the ice from melting between the ice delivery ashore and the fishing ground. This difficulty is, of course, most pronounced in warm or tropical climates.

Recent studies in Denmark (Jensen and Hansen, 1973) were concerned with the development of a new boxing system, 'ISIBOX', involving insulation of the ice during the journey to the fishing grounds. It was shown that plastic boxes of the nesting type could be used to hold the ice. The ice was placed as a layer in the bottom of the boxes which were well insulated against the sun and wind when stacked on the deck of an open boat. However, practical trials at sea (Jensen and Hansen, 1973; Bjergskov, 1973) revealed that the boxes, as originally designed, lacked stability when stacked with fish on board small open vessels.

Further studies have now been undertaken in Denmark to improve the original 'ISIBOX' system and provide some technical details of the application for coastal vessels, particularly in developing countries. The following account is an example of the installation of units of six plastic boxes, which will hold about 240 kg of fish and 60 kg of ice, on the deck of small coastal vessels. This quantity of ice will lower the fish temperature by about 20°C which will be a very valuable contribution to preserving the fish in tropical climates (Disney *et al.*, 1974).

In the present studies, an example is given of a stowage unit based on an existing type of plastic box with accessories which may easily be provided and repaired anywhere. It is further considered that in some developing countries the fishermen may depend on plentiful labour but not always on the presence of cranes, quays and other technical harbour facilities.

It should be noted that coastal fisheries vary greatly and that the stowage unit described cannot meet the requirements everywhere. According to local conditions, smaller or larger units, or a number of units, may be used and the unit may be combined with other stowage and chilling systems.

## The box unit with accessories

The original 65 litre box (Jensen and Hansen, 1973) was found to be too high and narrow to provide reasonable stability on board small open vessels. For the present studies the 75 litre Allibert box (No. 12075), which is 885 mm long, 560 mm wide and 235 mm deep, was chosen. The distance between two box bottoms is 68 mm, leaving room for about 11 kg of ice when the boxes are nested. When the boxes are stacked on top of one another, each box will hold about 40 kg of fish on top of the ice. In order to facilitate the heat exchange between the ice and the fish, the cold melt-water should pass freely through the box bottoms, which may be either perforated or of a ribbon type (Jensen and Hansen, 1973).

When six boxes are placed on top of each other, the top of the unit will be about 130 cm above deck level, which is considered a reasonable maximum from an ergonomic point of view. Two men will be required for the handling of a full box weighing about 55 kg. One box holding only ice weighs approximately 15 kg and six boxes with ice in the nesting position are only 66 cm high (Figure 1). The overlapping sides of the boxes, when in the nesting position, provide some insulation for the ice but, for further insulation, the unit should be provided with a separate bottom section, a lid and a canvas or oilskin cover protecting the four sides. This cover may be attached to the lid.

The bottom section should provide insulation, allow the passage of melt-water and secure the unit firmly in its position on deck. It may consist of a strong wooden frame filled with a rigid insulating material between sheets of aluminium plate. The section should have drain holes and the frame should be provided with slots intended for the rope holding the stack in position (Figure 2).

The lid should insulate the unit against the heat of the sun and the wind, protect it against rain and sea water and secure the canvas sides. The lid should overlap the top box by about 20 mm on all sides to allow for the fitting of the canvas sides over the unit. The lid may consist of a wooden frame surrounding a plate of insulating material, both sandwiched between sheets of aluminium for protection against radiant heat. The canvas or oilskin sides may be in one piece, 325 cm long and 130 cm wide, one side of which should be nailed around all four sides of the lid with some overlap of the two ends of the canvas length. It should not be too rigid to be folded over the lower part of the unit when in the nesting position.

The rope and hook arrangement to ensure the stability of the unit on board is described.

## Loading of ice

The unit of six boxes in the nesting position holds about 66 kg of ice forming a compact block interleaved by the box bottoms. If the boxes have ribbon bottoms as previously described (Jensen and Hansen, 1973), dry flake ice may be placed in the nested unit. The use of a vibrator attached to the unit will facilitate the ice filling and increase the amount of ice in each box by about 10%.

Figure 1
Cross section of complete unit with boxes nested

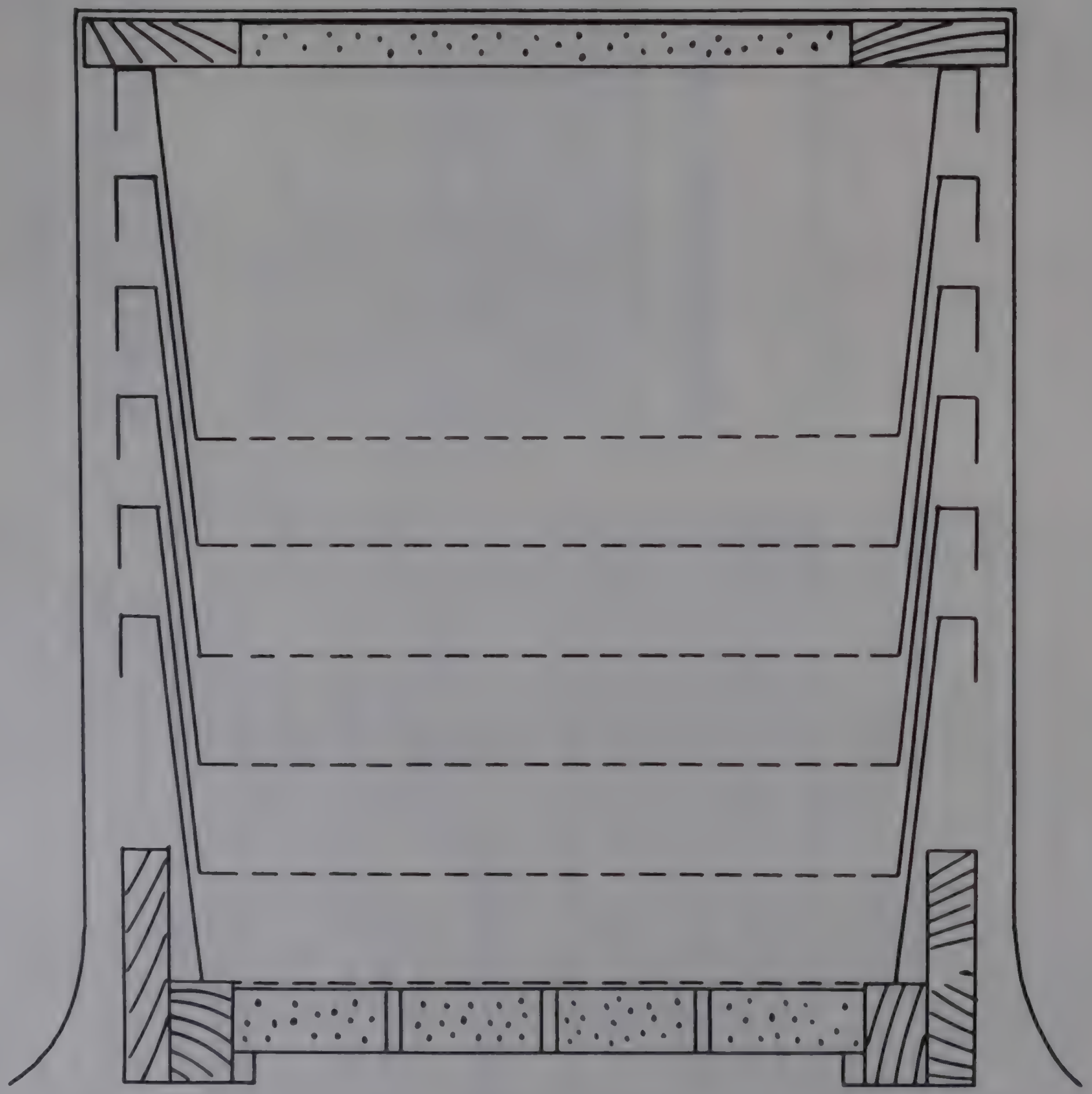
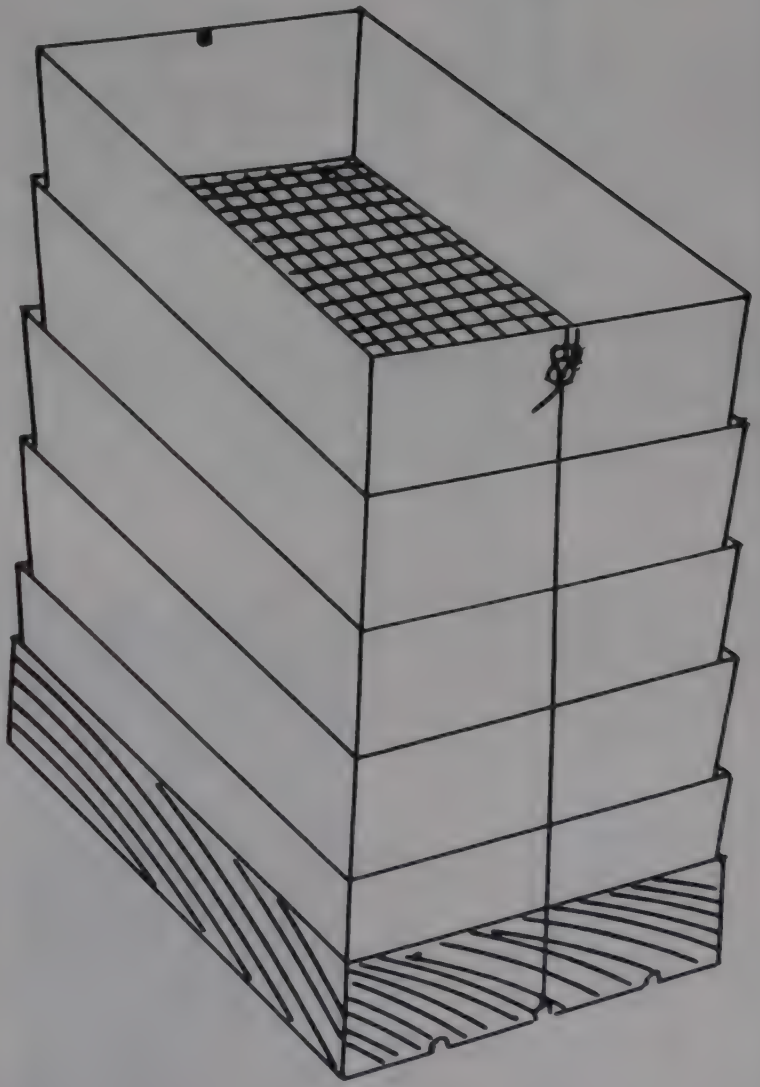


Figure 2
Stacked unit with top and side covers removed



Other types of ice cannot be put into the nested unit easily. The quantity of ice required must be added to each box manually. In this case the ribbon bottom is not required and may be replaced by circular holes approximately 10 mm in diameter.

The ice should be spread by hand into an even layer before the next box is placed into position for ice filling. It may be convenient to build up the units of six boxes with ice immediately following the washing of the boxes. The top box may be filled completely with ice in cases where an ice reserve is required.

### Transfer of the unit to the vessel

The transfer of the unit with ice from the ice plant to the vessel may sometimes involve intermediate storage ashore and transport by lorry. The units should in both cases be protected against strong heat and wind. Transfer by gaff truck and a quayside crane is recommended where the distance is short. Where such facilities are not available, the boxes may be transferred manually in which case it is important to reduce the time in which the unit is dismantled.

### Stability at sea

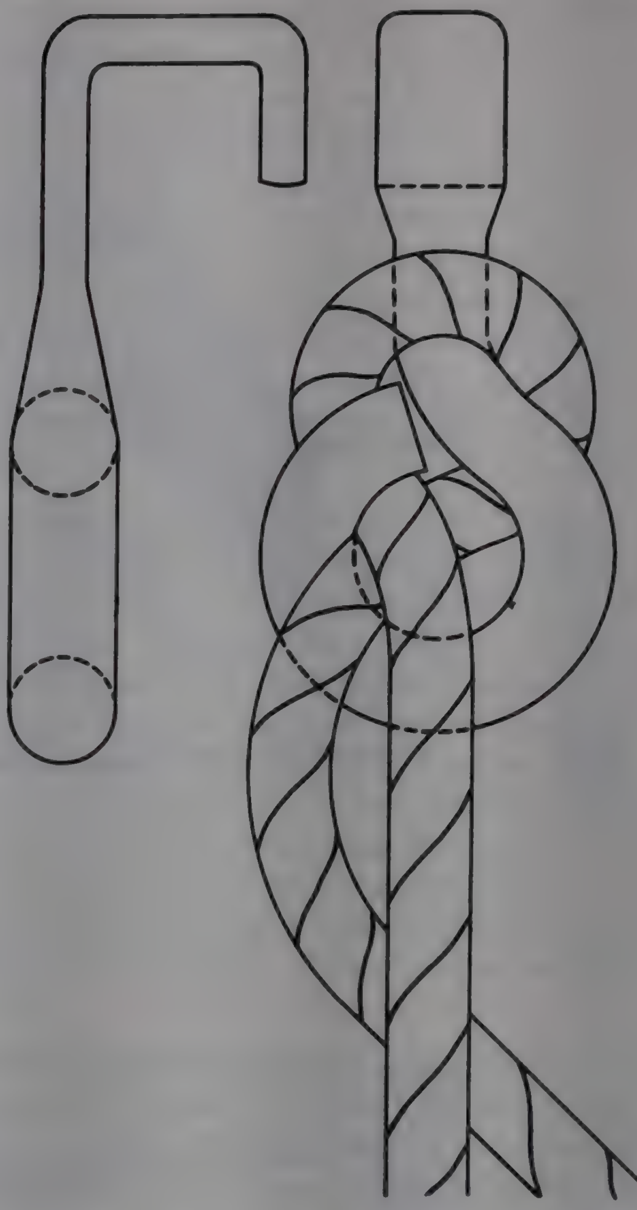
In order to reduce the stability problems at sea, the unit should be placed at right angles to the length axis of the vessel. It may be necessary to secure the bottom section firmly to the deck. It will often be necessary to secure the unit while it is being filled up with fish and during the return journey. Figure 2 shows an arrangement with a rope and hooks designed to prevent the stack from tipping over due to the movement of the vessel in the sea. One end of the rope is fitted with a hook which is placed on the handle of the top box. The rope is passed under the unit, hooked onto the other handle of the box and tightened. Figure 3 shows the special design of this second hook, which may slide along the rope when required while the unit is filled with fish. When the unit is full, the lid and canvas side are placed over the unit including the rope and hook arrangement.

### Ice packing of fish on board

The fish, when caught, will often move violently for a while and intermediate stowage on deck may be necessary before starting to sort the catch according to size and species for packing in different boxes. Care should be taken not to lose ice by packing live fish in boxes. Single boxes, placed on deck during filling with fish, do not normally present stability problems. As soon as a box is full it should be placed on the bottom frame and, as more boxes are put on top, it may be necessary to apply the rope and hook securing method to prevent the stack from falling over. The complete unit should be fastened to the deck when the vessel returns to shore or moves to another fishing ground, in which case full boxes are placed at the bottom and boxes with ice only in the upper part of the unit.

The stability problems are most serious when the unit is fully loaded with fish and ice, ie when it is 130 cm high and weighs about 300 kg, and it is, therefore, essential to have it well fastened and secured to the deck on the return journey.

**Figure 3**
**Hook for holding down boxes and detail of the method for fastening the rope**



### Unloading and handling on shore

A quayside crane could unload the entire unit. If a crane is not available, the unit may be dismantled for manual unloading of the boxes one by one.

At this stage, most of the ice may have melted and more ice may now be added on top of the fish in each box to complete the chilling and to keep the fish cool during the subsequent transport and distribution ashore.

It is essential to wash the plastic boxes immediately after use. The cleaning of the boxes may, in some cases, be combined with refilling with ice and restacking into 'ISIBOX' units.

### References

**Bjergskov, T.** (1973) Unpublished report. Technological Laboratory, Danish Ministry of Fisheries.

**Disney, J. G., Cole, R. C. & Jones, N. R.** (1974) Considerations in the use of tropical fish species. In: *Fishery products* (ed. R. Kreuzer), pp. 329–337. Surrey: Fishing News (Books), 463 pp.

**Jensen, J. and Hansen, P.** (1973) New system for boxing iced fish. *Fish. News Int.* **12** (4), 36–40.

# Handling and transportation of fish in India

**P. A. Perigreen and M. R. Nair**
Central Institute of Fisheries Technology, India

**Summary**

The pattern of handling and transportation of fish in India, where 65 per cent of the total fish landings is marketed in fresh condition, remained more or less unchanged until recent years. Unscientific methods are being used even now in some parts of the country. This paper describes briefly various aspects of handling fish on board fishing vessels and at landing centres, conventional type of containers and mode of transport used in the fish trade, and recent developments in the field of internal distribution of iced and frozen fish. The present methods of handling and transportation of frozen prawns, the most important export fishery products of the country, are also discussed.

**Résumé**

Les modalités de manipulation et de transport du poisson en Inde où 65 pour cent de la quantité totale des produits de la pêche est vendue sous forme de poisson frais sont restées plus ou moins inchangées jusqu'à ces récentes années. Des méthodes à caractère non scientifique sont utilisées même actuellement dans certaines parties du pays. Cet article décrit brièvement divers aspects de la manipulation du poisson à bord des bateaux de pêche et dans les ports de pêche, les types traditionnels de boîte et les moyens de transport utilisés pour le commerce du poisson ainsi que les récentes améliorations réalisées en ce qui concerne la commercialisation du poisson réfrigéré et congelé à l'intérieur du pays. Les méthodes actuelles de manipulation et de transport des crevettes roses congelées, les produits de pêche du pays les plus importants pour l'exportation sont également étudiés.

**Resumen**

El sistema de manipulación y transporte del pescado en la India, donde el 65 por ciento de las descargas pesqueras totales se comercializan en fresco, ha seguido siendo más o menos el mismo hasta los últimos años. Todavía hoy se están usando métodos no científicos en algunas partes del país. El artículo describe brevemente aspectos varios de la manipulación del pescado a bordo de las embarcaciones y en los centros de descarga, el tipo convencional de contenedores y el modo de transporte usado en el comercio del pescado, así como los avances recientes en el campo de la distribución intena del pescado congelado y refrigerado en hielo. También se discuten los métodos actuales de la manipulación y transporte de las gambas congeladas, las cuales constituyen los productos pesqueros de exportación más importantes del país.

## Introduction

The fish landing centres in India are scattered all along its coastline which is approximately 4800 km in length. The fish catches are showing an upward trend following the rapid mechanization of fishing craft and it is estimated that about 65 per cent of the total fish caught is marketed fresh (Table 1).

TABLE 1. *Disposition of fish catch in India in 1973*

| *Category* | *Quantity (tonnes x $10^3$)* |
|---|---|
| Fresh | 1,278.6 |
| Frozen | 105.5 |
| Sun-dried | 379.7 |
| Canned | 15.9 |
| Reduction | 104.4 |
| Miscellaneous | 73.9 |
| Total landings | 1,958.0 |

Source: FAO, 1974

The pattern of distribution of fish in India has remained more or less unchanged until recent years in spite of the rapid progress made in the fields of fishing and fish processing. Prawns which constitute 10 to 12 per cent of the total marine fish landings are mainly preserved by the modern techniques of freezing and canning. Approximately 90 per cent of the total marine landings and all the freshwater fish landings do not find an export market and recently attention has been turned to their handling and transportation within the country. Employment of quick means of transport such as trucks and vans has, to some extent, helped to ease the situation and more fish now find their way to the interior markets. A few refrigerated rail-wagons have been introduced along selected routes for transportation of fish to interior cities. However the quantity of fish which they can handle is negligible compared with the vast surplus available for distribution, especially during heavy fishing seasons.

## Handling at landing centres and on board fishing vessels

In India about one lakh (100,000) indigenous fishing craft and twelve thousand mechanized boats are used for fishing. The indigenous fishing craft and small mechanized boats (7.6 or 9.1 m overall length) do not carry ice for preserving the catch. The fishing trips of these boats last only for 6 to 12 hours and the catch reaches the shore un-iced. The catch from the boats, which reach the shore within 4 to 5 hours after capture, is in prime condition although no icing was done on board whereas 25 to 30 per cent of the fish reaching the shore after 8 to 12 hours is spoiled. After landing, the fish are sorted according to species and size and are either sold in the local markets or transported to towns and cities in the interior. The prawns are collected by the agents of the prawn processing factories, stored in ice until sufficient quantities are collected and then transported to the peeling sheds or to the factories, which may be located hundreds of kilometres away from the landing centres.

At present, refrigerated sea-water is not used for preserving fish on board fishing vessels. Larger fishing vessels, of overall length 10.95 to 15.24 m, can stay at sea for 3 to 6 days and are provided with insulated fish holds which have capacities of 5 to 12 tonnes depending on the size of the vessels. Some of the even bigger vessels are equipped with brine freezing systems, for immediate freezing of the material, and cold storage facilities. Since prawns are good foreign exchange earners, these vessels collect only prawns; other fish are usually discarded. The prawns are immediately headed after capture in order to reduce the bulk, washed with sea water and frozen in small batches by immersion in chilled sodium chloride brine at -15°C. After freezing, the material is transferred to the ship's cold storage facilities.

## Mode of transport and containers used

All means of transport commonly employed for carrying other agricultural produce are also used for transporting fish. The chief forms are head loads, shoulder slings, bicycles, motor vehicles, rail-wagons and boats. The use of a particular means of transport depends upon the distance to be travelled, the quantity of fish to be transported, the facilities available for quick and safe despatch, and the expenses that will be incurred.

Bamboo baskets are universally used in the fish trade; their capacity varies from 15 to 50 kg. Wooden boxes are used for long-distance transport of fish. In many parts of the country, second-hand tea chests made of plywood are used for this purpose. These containers are cheap but have poor insulation properties and are not hygienic. Aluminium and galvanized iron vessels are used for transporting iced fish to the processing factories. Rigid plastic containers are rarely used for storing fish in processing factories.

In a tropical country like India, ice melts rapidly making frequent re-icing necessary to maintain the fish at low temperatures. In most of the fish landing centres, shortage or even non-availability of ice is acutely felt. Even when plenty of ice is available, it is essential that it is used economically to keep the cost of the fish down. This necessitated the development of well-insulated, cheap containers for storage and transport of fish.

Improvements have been effected to the traditional bamboo baskets by making additional inside linings with bitumen-coated kraft paper or gunny and polythene. Considerable improvements in storage life of fresh fish (eg sardine, mackerel, jewfish etc) packed with ice in the ratio 1:1 in these containers have been observed (Rao and Perigreen, 1964). A more sophisticated container developed for long-distance transport of fish (both iced and frozen) is a thermocole insulated plywood box (Anon., 1965; Perigreen, 1968). Thermocole slabs (20 or 25 mm thick) are cut to the internal measurements of the box, sealed in polythene bags to prevent the thermocole from coming in contact with melt-water and placed on all the sides in the box. The storage life of iced and frozen fish in different containers is given in Tables 2 and 3. A drip proof insulated bamboo basket for transport of iced fish has also been introduced (Dani, 1968).

TABLE 2. *Storage life of iced fish in different containers*

| | |
|---|---|
| Ratio of fish to ice | 1:1 |
| Ambient temperature | 26–32°C |
| Maximum storage temperature attained | 3–5°C |

| *Container* | *Maximum storage life (hours)* |
|---|---|
| Bamboo basket | 9–10 |
| Bamboo basket lined with kraft paper | 16–17 |
| Bamboo basket lined with gunny and polythene | 16–18 |
| Plywood box (plain) | 14–16 |
| Plywood box lined with 25 mm thermocole | 50–55 |

During seasons of glut, when the whole of the fish landings cannot be transported immediately to the internal markets, they can be deep frozen and stored at or near the landing centres and transported according to demand. This method is now practised in some of the big cities of the country.

TABLE 3. *Storage life of frozen fish packed in different types of containers and stored at different temperatures*

| *Container* | *Fish studied* | *Storage temperature (°C)* | *Maximum storage life (hours)** |
|---|---|---|---|
| Plywood box – uninsulated | Sardine – glazed blocks | 4–7 | 96 |
| Plywood box – uninsulated | Sardine – glazed blocks | 25–30 | 42 |
| Plywood box – insulated with 25 mm thermocole | Sardine – glazed blocks | 26–32 | 90 |
| Plywood box – insulated with 25 mm thermocole | Sardine – individually frozen | 26–32 | 55 |
| Plywood box – insulated with 25 mm thermocole | Synagris – glazed blocks | 4–6 | 192 |
| Plywood box – insulated with 25 mm thermocole | Seer – individually frozen | 26–32 | 67 |

*Maximum temperature attained 1–3°C

TABLE 4. *Comparison of transport of iced fish in uninsulated and insulated trucks*

| | |
|---|---|
| Ambient temperature | 25–32°C. |
| Initial temperature of fish | 3–8°C. |
| Ratio of fish to ice | 1:1 |

| | *Loss of ice during transport (%)* | | | | | |
|---|---|---|---|---|---|---|
| | *Uninsulated truck* | | | *Truck insulated with 10 cm thermocole* | | |
| *Container* | *6 hours* | *10 hours* | *16 hours* | *8 hours* | *15 hours* | *20 hours* |
| Bamboo basket | 60–65 | 80–85 | – | 40–50 | 85–90 | – |
| Plywood box | 50–55 | 65–70 | 90 | 35–40 | 60–65 | 80 |
| Galvanized iron vessel | 60 | 75–80 | – | 45–50 | 90–95 | – |

## Transportation of raw material to fish processing factories

Supplies of raw material (mainly prawns) to the processing factories are transported either by trucks, trains or carrier launches. On the southwest coast of India. raw materials are received at Cochin from Trivandrum, Mangalore and Malpe. Substantial quantities of raw material are moved by road from Ratnagiri to Bombay. The distance covered in these journeys ranges between 100 and 500 km. Fairly large quantities of prawns are transported from Visakhapattanam and Kakinada to Madras and Cochin by rail. Prawns and lobsters are transported in insulated carrier vessels from Veraval to Bombay (Indian Institute of Foreign Trade, 1970).

Vehicles used for transportation of fish to the processing factories are either open, closed (uninsulated) or insulated trucks; of these, open and closed (uninsulated) trucks account for about 75 per cent of the total number. Therefore the number of refrigerated and insulated vans is inadequate to meet the industry's requirements.

Almost twice as much ice has to be used in the case of transport in uninsulated trucks as compared to transport in insulated trucks. It is estimated that two tonnes of ice are used in uninsulated trucks for every tonne of raw material as against one tonne in insulated trucks. It also decreases the capacity of the truck since two-thirds of the space is occupied by ice alone in open or closed uninsulated trucks. In the case of insulated trucks, only half of the space is occupied by ice. The loss of ice during transport, in uninsulated and insulated trucks, of fish packed with ice in different containers is given in Table 4.

## Handling and transportation of frozen prawns for export

Frozen prawns constitute about 80 per cent of India's export earnings from marine products. The prawns, stored in ice, which reach the processing factories from different centres are frozen in different forms eg peeled and de-veined, headless or cooked. The prawns are generally frozen in 2.27 kg glazed blocks. These frozen blocks are wrapped in polythene sheets and packed in waxed paper-board cartons. Ten such cartons of prawns are placed in a master carton made of corrugated paperboard and stored at –23°C until exported.

All the processors at present are taking utmost care of the prawns stored in their factory. However, difficulty arises during the transportation of the frozen cargo from the cold store to the wharf and in transferring the cargo from the trucks into the reefer compartments of the ship. The master cartons containing the frozen material are transported to the wharf for shipment either by refrigerated trucks, refrigerated rail-wagons or insulated vans. At present, only a few processors use refrigerated trucks;

the bulk of the frozen prawns is transported in insulated trucks. Generally the transportation of frozen cargo takes place either in the evening or at night since the ambient temperature is low at that time. Even under these conditions, wide fluctuations in the temperature of the frozen material have been observed during transportation for shipment. Typical examples are given in Figures 1 and 2.

**Figure 1**

**Transport of frozen prawns in insulated truck. Position of master carton — near the door of the truck. Ambient temperature 24–26°C**

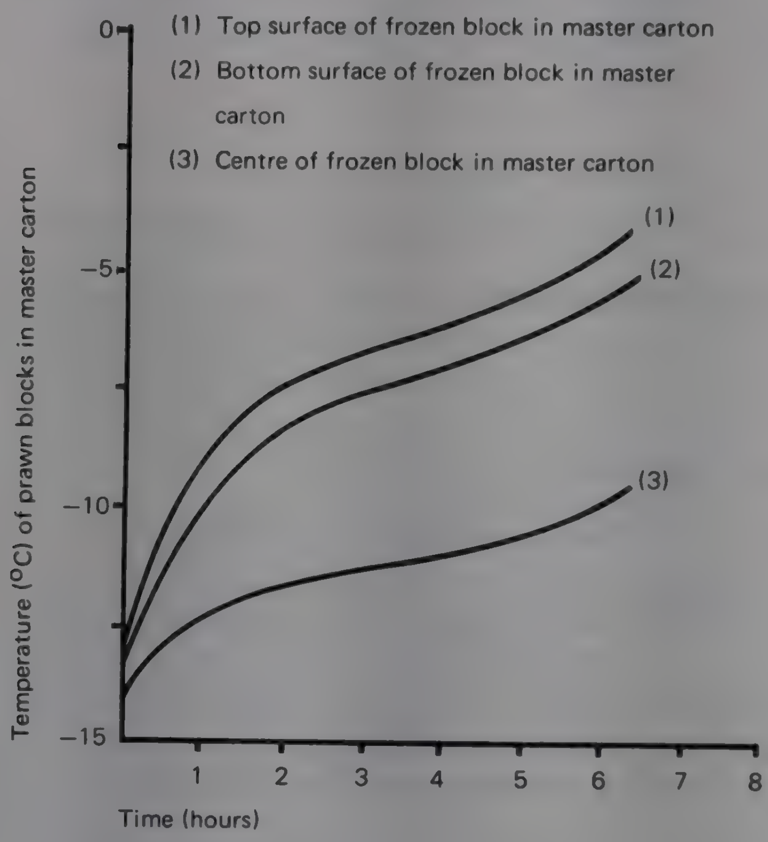
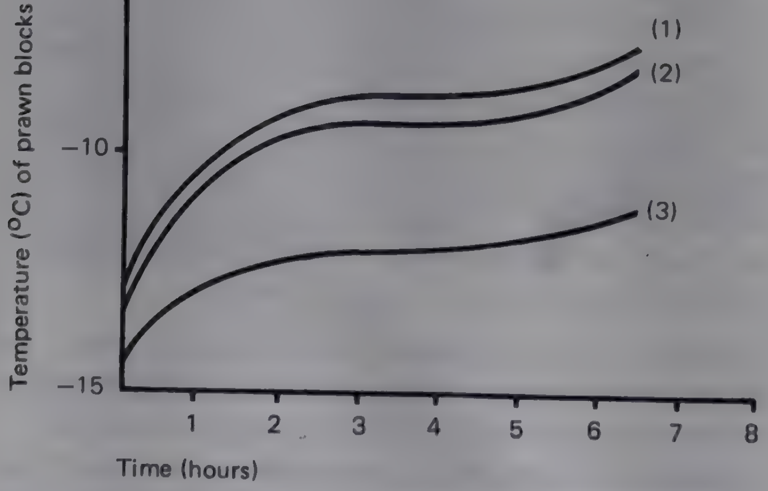


**Figure 2**

**Transport of frozen prawns in insulated truck. Position of master carton — at the centre of the truck. Ambient temperature 24–26°C**



The main fluctuations in temperature of the frozen prawns take place during loading (from the cold store in the factory to the truck), which usually takes 30 to 60 minutes. With the enormous increase in the number of processors, the loading of the frozen cargo into the ship is also subject to much delay, the time taken waiting at the wharf sometimes being 6 to 8 hours.

## Use of solid carbon dioxide or liquid nitrogen in transportation of fish

In India, solid carbon dioxide (dry ice) or liquid nitrogen is not at present used in the transportation of fish although some work has been done in this field. It has been shown that solid carbon dioxide or liquid nitrogen can be used for the supplementary cooling of already chilled or frozen material during transport in insulated vehicles. One of the reasons for not using solid carbon dioxide or liquid nitrogen is the prohibitive cost of these cooling agents in India.

## Conclusion

An attempt has been made to give a brief account of the handling practices and transportation of fresh and frozen fish in India. In recent years sufficient progress has been made in the fields of handling and transportation of fish, especially prawns which are the most important export fishery product of the country, although unscientific methods are still being followed in some parts of the country. The conventional type of containers used in the fish trade have been modified using cheap insulation materials and these modified containers are now used for transportation of fish to interior markets. The number of insulated and refrigerated trucks and rail-wagons used for transportation of fish has also increased in recent years. Since approximately 65 per cent of the total fish landings is marketed in a fresh condition, all attempts are being made by the Government and private agencies to increase the facilities for transportation of fish to the interior markets as this will ensure better economic utilization of the fish landings and help to improve the socio-economic status of the fishermen.

## References

**Anon.** (1965) *Fish Technol. Newsl.*, **6** (2), 4.

**Dani, N. P.** (1968) *Seafood Exporter*, **3** (1), 117.

**FAO** (1974) *Yearbook of fishery statistics*, Volume 37. *Fishery commodities*, 1973. Rome: FAO.

**Indian Institute of Foreign Trade** (1970) *Survey of India's export potential of marine products*, **2**, 107.

**Perigreen, P. A.** (1968) Studies on transportation of fish. 1. Packaging of frozen fish in insulated containers. *Fish. Technol.*, **5** (1), 43–48.

**Rao, C. V. N. & Perigreen, P. A.** (1964) Studies on packaging of fresh fish. *Fish. Technol.*, **1** (1), 68–75.

# Note on the distribution of live fish in Thailand

**Bung-Orn Saisithi**
Department of Fisheries, Thailand

In general, the fish sold alive in Thailand are freshwater species. The freshwater catch is approximately 10% of the total catch, which in 1974 was 1,510,466 tonnes.

For transportation, the live fish are placed in metal tanks filled with water. The tanks are of two sizes; the larger is 94 x 51 x 51 cm and holds 60 kg of catfish or 40 kg of snake-head fish whereas the smaller is 76 x 31 x 43 cm and holds 40 kg of catfish or 30 kg of snake-head fish. Most (ie 90%) of the tanks are transported to the retail markets by road; the remainder go by boat. Approximately 80 to 95% of the fish are still alive on arrival at the market and these fetch the highest price. The price of fish, which have just died, may be reduced by as much as 30 or 40%. Dead fish, which have started to spoil, are processed rather than sold as 'fresh'. Processed fish, such as those which has been salted and dried, attain only about 40 or 50% of the price of live fish. On the other hand fish, which are too stale to produce an acceptable salted and dried product, can be processed by fermenting. Fermented fish sell for approximately 20% of the price of live fish.

# Discussion

For this session there were four discussion periods: one after the presentation papers and one after each of the three groups of papers reviewed by the moderator.

### Papers 1 and 2

The first part of the discussion touched upon the suitability, in terms of design and type, of landing facilities and ice plants for fisheries in the tropics. Problems in developing small-scale fisheries, the topic of **Lisac's** paper, were considered further in the third part of the discussion for this session. The remainder of the discussion centred on the delays which may be allowed, prior to icing fish in the tropics, without seriously affecting subsequent storage life.

**Cole** opened with a comment on the origins of the chilled sea-water (CSW) method in Malaysia. Fish from a near-sinking vessel were, on landing, of better quality than conventionally iced fish. These fish had, in effect, been stored in ice and sea water. He added that, if properly applied, this is an excellent chilling method for small fish; if mis-used CSW (as any other chilling method) gives poor results.

Following on, **Sabri** asked **D. James** (representing **Lisac**) to elaborate on the practicality and design of landing facilities, particularly floating wharves, for a country such as Malaysia where there are many constructional problems, eg silting. **James** suggested that the landing facilities of Real Province, Indonesia, could be taken as an example (Mulyanto of Indonesia has published details). Each situation demands its own design; FAO would be pleased to supply a design. **James** also mentioned that floating wharves are used on some of the African rivers.

A short discussion on the types of ice plant suitable for use in the tropics followed. In response to the chairman's question, **James** replied that the type and size of plant will depend on local conditions and facilities. Also, the economics of production and the choice between a large centralized plant and small scattered facilities must be carefully considered. **Okedi** commented that the operation and maintenance of ice plants has been a problem in East Africa; he considered education in 'good icing practice' to be essential.

A question from the chairman stimulated a discussion on the number of hours tropical fish can be kept at ambient temperature. **Kamari** said that *Rastrelliger* spp. were completely spoilt within 5 hours and pomphret, if left for 6 to 7 hours at ambient temperature, were still acceptable. He felt that fish should be kept for no longer than 5 hours before icing. It was pointed out by **James** that spoilage in tropical climes depends on the species and the situation; this was endorsed by **Okedi**. **James** noted that fish stored for 10 days in ice would be in the same condition as fish kept for 18 hours at ambient temperature. **Disney** then spoke of the iced storage trials carried out in East Africa; it was found that, for the freshwater species studied, one hour at ambient temperature is approximately equivalent to one day's storage in ice. He added that in many artisanal fisheries it is impossible to apply ice on the boat, hence it is of great value to establish how long different species can be kept without icing. Further trials showed that for some species delays of 6 to 9 hours, after capture and before icing, did not significantly affect the subsequent iced storage life (of approximately three weeks).

It was suggested by **Okedi** that whilst icing may be very suitable for fishermen in urban areas, this may not be the case for fishermen in remote situations; more attention should be paid to improving traditional techniques (the subject of Session 6).

Finally, the chairman asked if there are any countries where it is mandatory for instutional finance houses to assist small-scale fisheries. In reply, **James** said that FAO have published information on this point.

### Papers reviewed by the moderator

#### *Marketing*

This discussion centred upon the relative merits of different types of ice and on the problems of upgrading small-scale fisheries; marketing as such, was not discussed. Chilling, in broad terms, stimulated a lot of interest, further discussion taking place in the last discussion period of this session.

In opening the discussion, **C. E. P. Watson** noted that additional cash may not stimulate extra fishing effort in developing small-scale artisanal fisheries. Higher landing prices may, in fact, result in less fish being caught and landed since the fishing communities cannot absorb further cash. **Sabri** then asked the meeting to comment on the economic and socio-economic implications of changing from a small-scale to a medium-scale fishery. He was told by **James** that it is not always possible to upgrade the artisanal fisherman; the capital required for expansion is simply beyond their resources. **Taylor-Thomas** went on to point out that certain species can be fished only by traditional canoes and, although the change to medium-size boats is welcome, it is not, therefore, always practicable. (He also gave support to the statement in **Lisac**'s paper that improvements must be simple and cheap).

Other delegates from West Africa, **Golley-Morgan** and **Sagua**, felt that an integrated approach is necessary in order to overcome the fundamental problems (eg traditions, infrastructure, economics etc) of developing small-scale fisheries.

In response to the question from **R. James** on the currency conversions quoted in the second paper, **Arrundale** replied that the costings are out of date; the object of the paper was to anticipate the need for marketing infrastructure.

**James'** second question stimulated a lively discussion on the best type of ice for use in the tropics. For small-scale production, flake ice was recommended by **Arrundale** and **Waterman** and by **Disney** who added that the choice as to type of ice used in a particular fishery will depend upon the local circumstances. Sometimes, however, there is no choice since, as noted by **Moal** and **Sagua**, existing ice plants in the tropics are seldom used for fisheries alone; often they are associated with other industries. Examples of types of ice used for fisheries in different countries were given by **Faubeau**, **Hooi** and **Peterkin**. Both **Disney** and **Peterkin** commented that flake ice is more suitable for fish which are easily damaged; the latter noted that flake ice does tend to bind together in large lumps. A number of advantages of block ice over other forms were then put forward: blocks are more easily handled where facilities are primitive (**Waterman**, they can be transported on bicycles if necessary (**D. James**); and they melt more slowly (**Disney**). **Disney**, however, felt that flake ice has better cooling properties but **Waterman** commented that if the blocks are crushed into small pieces, both are equally effective.

On the question, from **Otitaku**, of freshwater versus sea-water ice, **Waterman** replied that ice made from fresh water is preferable; sea-water ice has a variable freezing point. He pointed out that if fresh water is not available, then clean sea water can be used. **Morales** put forward the view that the type of water used is not important but the elimination of polluting agents is essential. He suggested the possibility of adding a suitable chemical to the water.

Finally, the need to educate fishermen in the correct use of ice and in how to protect the fish plus ice with insulation was stressed by **Cole**. On another point, he mentioned that hardy, shallow-water demersal fish can be carried in live wells; this applies to marine as well as fresh-water species.

### *Analytical studies*

There was considerable discussion on the distribution of mercury (Hg) in fish and although there was no agreement on recommended standards it was felt that these would change as more information becomes available. The remainder of the period was tken up with points relating to the **Arroyo** paper.

In response to **Talabi's** question on the distribution of Hg in organs, **Mattos** replied that determinations were made only on the parts of the fish which are eaten. Questions from **Iyer** and **Diaz** and a comment from **Talabi** brought a detailed response from **Bligh**. Firstly, with regard to the 0.5 ppm Hg limit for seafoods, he felt that a detailed discussion on its justification could not be undertaken at this meeting. Secondly, **Bligh** pointed out that mercury is not associated with fats or lipids; it is bound to the sulphydhyl groups of muscle proteins and practically all the Hg is in the methyl form (ie toxic), except in the American eel where only 50% is methylated. Thirdly, he mentioned that there are few problems with marine species nowadays since small-size tuna are generally used; previously Hg contamination was a problem with large tunas and swordfish. Finally, he pointed out that the relatively high Hg levels in shark and dogfish are increased after salting and drying due to the removal of water; rehydration reduces these levels. Points two and three were endorsed by **Steinberg**.

Referring to the **Arroyo** paper, **Talabi** expressed surprise at the percentage flesh yield. From their experience with *Ethmalosa dorsalis*, meat yield is constant when the fish approach mature weight. **Arroyo** confirmed that the data are correct but pointed out that the fish were not filletted commercially, they were dissected. This point was further taken up by **Karnicki**. A few delegates contributed data for other species and it was agreed that similar detailed studies should be carried out on other commercially important species.

### *Handling and distribution*

This discussion dealt solely with the relative merits of the chilled and refrigerated sea-water (RSW) methods for chilling of fish.

**Iyer** opening the discussion, commented that intensive studies carried out at the Central Institute of Fisheries Technology have shown the RSW method to be very effective in prolonging the shelf life of fish, but there are two disadvantages: the heavy bacterial load of the fish and the difficulties of installing the plant on small trawlers. To overcome this problem on small inshore boats and bearing in mind the cost of the RSW method, **Bligh** recommended the use of ice and sea water in an insulated container; a system which is particularly suitable for small pelagics. He pointed out that CSW is very effective and requires little capital investment but care must be taken to ensure the stability of the vessels carrying CSW tanks. **Cole** agreed that CSW is very effective for small pelagics and noted that while there is some salt uptake this is not objectionable if, for example, the fish are boiled in salt water for distribution. He added that the CSW system also works well for shrimps and prawns, although it may be necessary to change the water every

24 hours. **Sorensen** felt that CSW could be used for the initial chilling of fish which could then be stored in ice (ie shelved) if bruising is a problem.

**Kamari** then pointed out that there is already a shortage of ice in many developing countries and suggested that a chilling method, which does not put further demand on ice supplies (eg RSW) is required. In praise of RSW, **Karnicki** told the conference that since 1966 they have had good results in Poland for pre-chilling fish on deep-sea trawlers. Both the CSW and RSW systems were commented by **D. James** as being excellent methods of chilling and he agreed that if ice is not available, refrigerated sea-water is the only alternative. If there is a choice of chilling methods, **James** stressed that the particular situation must be carefully looked at. He cited, as examples, the experiments on (a) the Moroccan sardine and (b) the Chilean langostino and hake; CSW and CSW in conjunction with air agitation were found, respectively, to be most suitable. Further comments were made by **Moal and Talabi** on the suitability of RSW for most pelagics. Finally, it was recognized that chilling always costs money whether ice alone, ice and sea water or refrigerated sea water is used.

# Session 4

## Frozen fish

**Tuesday 6th July**
**Afternoon**

Chairman
M. A. Steinberg
Department of Commerce
USA

Moderator
J. J. Waterman
Torry Research Station
UK

Rapporteur
J. F. Arrundale
British Development Division
in the Caribbean,
Barbados

# Frozen fish marketing in developing countries

**W. Krone**
Department of Fisheries, FAO, Rome

### Summary

The rapid development of marketing unsophisticated frozen fish products in some tropical countries is reviewed. Distribution margins and costs for frozen fish are compared with marketing of traditional fishery products. Future requirements and areas for techno-economic investigations are indicated.

### Résumé

Le développement rapide de la commercialisation du poisson congelé dans certains pays tropicaux est passé en revue. Les marges et les coûts de distribution du poisson congelé sont comparés avec la commercialisation des produits de pêche traditionnels. Des nécessités futures et des secteurs d'investigation technologique et économique sont indiquées.

### Resumen

Se hace una revisión del rápido desarrollo de la comercialización de productos corrientes congelados en algunos países tropicales. Se comparan los costos y márgenes de distribución del pescado congelado con la comercialización de los productos pesqueros tradicionales. Se hacen indicaciones sobre los requisitos futuros y áreas de las investigaciones técnico-económicas.

## Introduction

The rapid expansion of frozen food marketing, in which the fishing industry has participated, has been one of the most distinct developments in the food producing industries during the last thirty years. In addition to market forces, such as the trend to convenience products in industrialized societies and changes in the distribution infrastructure (chain stores, self-service retailing etc), factors on the production side accelerated this development. Fishing fleets of developed fishing nations had, to an increasing extent, to seek fishing grounds further away from the market and home base, thus necessitating processing of the catch at sea into stable products. Freezing aboard distant-water vessels offered the possibility of producing highly valued products and, at the same time, allowing the vessels to fish for a longer time; this improved the relationship between (productive) fishing days and (unproductive) steaming time.

Unlike other frozen food industries, the appearance of frozen fish products on the market was not restricted to developed countries. Frozen fish has become an important factor in the domestic marketing of fish in a number of developing countries during the last 15 years or so. However, this trade shows entirely different features from the marketing of frozen fish in developed economies. In the developed countries, sophisticated convenience products, such as fish fillets, fish sticks and portions, sold through supermarkets have been the primary development. This trade is, of course, also known in the bigger cities of developing countries, where it serves the higher income groups of the population, but it is insignificant in relation to the overall frozen fish market. Frozen fish is primarily distributed in developing countries in unsophisticated bulk packs; its distribution depends in many instances on the traditional fish trade in public markets or, sometimes, in fishmongers' shops. This is the type of frozen fish trade considered in this paper; a detailed description is given in a study made in 1969 in the West African region (Krone, 1970). Some costs and other comparisons are made with alternative fishery products and the outlook for the future indicated.

It should be noted that developing countries have, of course, participated to an increasing extent in the export, to international markets, of high value frozen fish products such as shrimp, tuna, squid, cephalopods and certain ground fish species (eg sole and hake fillets). This trade is likely to continue to expand, within the limits of resource availability off the coast of developing countries, provided that international standards of quality and hygiene and buyer specifications for these products are strictly adhered to (Ruckes and Krone, 1974).

TABLE 1. *World exports of fish and fishery products*

| Year | Total exports | | Food fish* | | Frozen fillets | | Miscellaneous, frozen | | Cured fish | | Canned fish | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *tonnes x $10^3$* | *US \$ x $10^6$* | *tonnes x $10^3$* | *US \$ x $10^6$* | *tonnes x $10^3$* | *US \$ x $10^6$* | *tonnes x $10^3$* | *US \$ x $10^6$* | *tonnes x $10^3$* | *US \$ x $10^6$* | *tonnes x $10^3$* | *US \$ x $10^6$* |
| 1968 | 7,692 | 2,225 | 4,143 | 1,840 | 327 | 170 | 556 | 192 | 485 | 221 | 608 | 429 |
| 1969 | 7,093 | 2,441 | 4,056 | 2,049 | 390 | 214 | 552 | 214 | 503 | 236 | 587 | 427 |
| 1970 | 7,337 | 2,895 | 4,331 | 2,404 | 434 | 276 | 606 | 231 | 519 | 270 | 606 | 474 |
| 1971 | 7,525 | 3,343 | 4,491 | 2,838 | 399 | 319 | 681 | 271 | 489 | 306 | 627 | 547 |
| 1972 | 7,957 | 4,022 | 4,949 | 3,522 | 393 | 364 | 764 | 384 | 516 | 380 | 697 | 675 |
| 1973 | 6,757 | 5,346 | 5,126 | 4,689 | 373 | 458 | 1,003 | 597 | 495 | 501 | 765 | 874 |
| 1974 | 6,958 | 5,833 | 4,998 | 5,094 | 311 | 432 | 1,071 | 607 | 425 | 572 | 765 | 994 |
| Change 1968–74 (1968 = 100) | 90.4 | 262.2 | 120.6 | 276.8 | 95.1 | 254.1 | 192.6 | 316.1 | 92.8 | 258.8 | 125.8 | 231.7 |
| Average unit values in 1974 (1968 = 100) | | 290.0 | | 229.5 | | 267.2 | | 164.1 | | 278.9 | | 184.2 |

* Excluding fish meals.

Source: FAO, 1975.

## Utilization of fish for freezing

In 1974, slightly more than one-quarter of all fish used for human consumption entered the marketing chain in frozen form at one stage or another. This proportion had increased from about 20 per cent in 1968 and 10 per cent in 1958. These data do not distinguish between quantities which may be frozen but which are subsequently processed into other fishery products such as canned, smoked or breaded sticks and portions etc. It is generally not possible to quantify the importance of different products, except in a few countries, where they are classed as relatively broad groups of products such as fish fillets, tuna and 'miscellaneous'. All these product groups have participated in the expansion of production and trade but to a different extent and at a different pace. The export of frozen fillets (including blocks to be further processed into convenience products such as fish sticks and portions) reached a peak in the early seventies at 400,000 to 430,000 tonnes but since then have dropped to 310,000 tonnes in 1974 (Table 1). While this trend has reversed somewhat in 1975, the trade is likely to continue to grow, although growth will be on much more modest lines than in the sixties (where it increased from 170,000 tonnes in 1958 to the figures given above). On the other hand, it is interesting to note the continuing and rapid expansion of exports of 'miscellaneous frozen products' from about half a million tonnes in 1968 to more than one million tonnes in 1974 (Table 1). Although for some countries this group includes tuna and some other relatively high value species, the main contributors have become frozen pelagic and ground fish in relatively unsophisticated packs (20 to 30 kg cartons of 10 kg blocks of whole fish, generally ungutted). A large part of this production is destined for developing countries. Participants in the trade on the exporting side are Poland, USSR, Spain, Japan, Bulgaria, Romania and, more recently, some developing countries such as Senegal, Mauritania, Peru, Cuba and The Gambia.

Table 2 shows the rapid expansion of frozen fish exports of some countries, notably the USSR and Poland. Together with Bulgaria and Romania, from which countries no precise data are available, these countries accounted for about half of the frozen fish exports in the 'miscellaneous' group. In 1975, Senegal exported about 30,000 tonnes of frozen fish (other than tuna), of which almost 25,000 went to West African neighbours, notably the Ivory Coast. Mauritania's shipments of frozen fish and shellfish to Japan, Spain, France and Italy amounted to about 15,000 tonnes in 1974.

TABLE 2. *Exports of miscellaneous frozen fish from selected countries (tonnes × $10^3$)*

| *Year* | *USSR* | *Poland*[a] | *Japan*[b] |
|---|---|---|---|
| 1958 | – | 2.5 | 20.0* |
| 1968 | 183.7 | 31.5 | n.a. |
| 1969 | 165.9 | 36.0 | n.a. |
| 1970 | 222.2 | 43.0 | 88.7 |
| 1971 | 261.1 | 37.2 | 89.1 |
| 1972 | 227.1 | 56.9 | 124.0 |
| 1973 | 246.2 | 63.2 | 154.9 |
| 1974 | 357.8 | 68.1 | 144.3 |

* Round figure

[a] Excluding frozen fish fillets

[b] Excluding frozen tuna, white fish fillets

## Frozen fish distribution in selected countries

The most important market for frozen fish has been West Africa where the trade started in the early sixties, notably in Ghana, Liberia and Nigeria. Present market volumes for all countries in West Africa are estimated at approximately 300,000 to 350,000 tonnes as against 100,000 tonnes in 1967. A large proportion of frozen fish deliveries is taken from freezer trawlers and factory vessels, operating under charter or other agreements with West African countries (eg vessels from USSR, Poland, Bulgaria, Rumania and Spain), or from shore plants (eg Senegal, Mauritania). Table 3 gives some indication of the imports of some countries. Imports are supplemented to a certain extent by national production, eg in Liberia, Nigeria and Cameroon, where some of the by-catches from shrimp operations are frozen in shore establishments for subsequent export or domestic distribution.

TABLE 3. *Imports of frozen fish of selected countries in West Africa during 1974 (tonnes × $10^3$)*

| *Country* | *Volume* |
|---|---|
| Cameroon | 7.6 |
| Congo (PR) | 2.0 |
| Ivory Coast | 73.7 |
| Liberia | 11.9 |
| Nigeria | 120.0 |
| Sierra Leone | 10.0 |
| Togo | 13.7 |
| Zaïre | 1.1 |
| *Total* | 240.0 |

Source: FAO, 1975.

Supplies include a wide range of demersal and pelagic fish. Prices vary with species, size and quality between US $200 and 300 per tonne CIF West African port.

Frozen fish landings of the Egyptian high-sea fisheries in 1975 amounted to approximately 17,000 tonnes and are planned to increase to 70,000 tonnes by 1985. In addition, 18,000 tonnes of frozen fish were imported in 1975 and this is expected to increase to 30,000 tonnes in 1976. Average import prices are around US $300 per tonne.

In Peru, the distribution of frozen fish was initiated in 1971 with supplies coming from foreign vessels operating under joint venture agreements and to a lesser extent from shore freezing plants. During 1975 approximately 1,000 to 1,500 tonnes were distributed per month. Prices at the landing stage were equivalent to US $150 to $400 per tonne, depending on species and grade.

The rapid increase in fish consumption in Cuba, which more than doubled between 1967 and 1974, is chiefly based on supplies of frozen fish from its new distant-water fleet and from imports although exact figures are not available.

These are just a few important examples where frozen fish plays a significant role in the domestic marketing of fish, particularly aiming at the middle and lower income groups of the population. In all cases, development was stimulated by the establishment of a cold chain consisting of small- or medium-size cold storage depots in the interior which are supplied from a large-scale cold store at the coast. From the depots, the product is delivered to retail traders either in its original wholesale pack or defrosted. In West Africa, the private traders, who are women, usually collect their daily supplies at the depot. In some countries, the system has been vertically integrated by the establishment of company- or state-owned and operated retail shops eg in Egypt and Cuba and, to some extent, in Ghana and Peru.

In some of the countries mentioned, a very high standard has been followed in establishing the cold chain, while in others the distributors were satisfied with installing relatively simple equipment. The latter can generally be regarded as acceptable provided the product temperature can be kept at a reasonably low level. A slight rise in temperature may be tolerable because the product is sold quickly. Temperature rise during transport in insulated trucks is also unavoidable and the use of refrigerated lorries would not improve the situation because the bad roads would cause breakdown of the refrigeration unit. Although there are problems with quality deterioration, it should be borne in mind that the quality of the fish is still by far superior to that which consumers were or are accustomed to receiving from the fresh or cured fish trade.

In all cases, the main stimulus has been that frozen fish became readily available either by imports or through joint arrangements with operators of freezer and factory vessels. Shore freezing is gradually developing in most of the countries concerned but this new industry is usually geared to export markets (eg shrimp, hake, cephalopods) and production for the domestic frozen fish chain is often incidental. With an assumed market developing, however, it can be anticipated that this will be supplied increasingly by a shore industry.

It is apparent that the modern and efficient distribution system which has been set up does not greatly benefit the small-scale artisanal sector of the national fisheries. Similar situations have been experienced in other fisheries, including those in developed countries, where it has been difficult or impossible to integrate a small-scale fishing operation into industrial processing and vice versa. It would seem certain that a freezing industry is not the best outlet for small-scale fisheries in developing countries. Extension and intensification of traditional small-scale operations have to receive primary attention.

Although artisanal fisheries do not generally benefit from this marketing development, there are no indications that they have suffered greatly from the competition. Marketing areas, species and products, as well as sales strategies, are usually sufficiently different, thus guarding against detrimental effects on small-scale fisheries. In other cases, governments have taken policy measures (quotas, customs duties, restrictions in distribution etc) to protect the small-scale operator's interest.

## Comparisons with alternative products

While it is unquestionable that frozen fish has been an important factor in expansion and modernization of fish distribution in a number of developing countries, it may be questioned whether alternatives were not available or why, if it has been shown to have definite advantages, freezing has not been introduced on a similar scale in other countries. It is obvious that certain conditions are necessary to make this system viable in comparison with other product approaches. Before briefly analysing these, let us re-iterate the most important advantages of frozen fish:

(a) Long storage life, preserving the fresh fish characteristics.
(b) Possibility of stabilizing supplies and prices
(c) Possibility of rationalizing distribution and keeping products continuously available.
(d) Standardization of products, packs and quality.
(e) More effective promotion and consumer education.
(f) Flexible retailing in markets or in stores, as frozen fish or in defrosted form.

Frozen fish share some of these advantages with other products, such as canned or dried fish, but they would not be sufficient in themselves to explain the evident breakthrough. Two factors have been of decisive influence; these are consumer preference and distribution cost. Both should be briefly analysed in relation to fresh fish as well as to traditionally smoked/dried fish.

Where there is a consumer preference for fresh fish, frozen fish should offer considerable potential, provided due regard is given to quality standards. Even for consumer groups which have become accustomed to traditionally processed products such as dried or smoked/dried products, fresh fish (from inland waters) or defrosted frozen fish when offered at a reasonable price are preferred. There are of course important trades in dried or smoked/dried fish and this product continues to play a central role in many food preparations in developing countries. However, the end use must be considered. Under these circumstances, dried fish is used in a completely different way. The staple diet is cereal covered with a sauce which contains crumbled dried fish as a condiment. The difference in demand and use can be compared with the difference in the end use between beefsteaks and bouillon cubes or liquid meat extracts. The lower income groups cannot afford sufficient animal protein to make it a major part of a meal. Fresh and frozen fish, therefore, have a better consumer image which helps in all marketing efforts.

As to distribution costs, it is important to base comparisons on similar assumptions. For example, large-scale distribution of frozen fish to distant markets cannot really be compared with peddling small baskets of fresh fish in the neighbourhood of the landing place. If the comparison is made with larger scale fresh fish distribution, involving icing, boxing, and transport by insulated truck, the result would often be in favour of the frozen fish system because there is an assured full load, higher stowage rate (as compared to iced fish in boxes) and greater marketing flexibility. The higher investment in cold storage facilities (moderately higher because an efficient fresh fish distribution scheme also needs chill storage at both ends of the marketing chain) will probably be more than compensated for by the operational advantages resulting in cost savings.

It is also not entirely appropriate to compare the distribution costs of frozen fish with the expenditure of a peddler of dried or smoked fish. His out-of-pocket cost will probably be low but his average turnover is also extremely low and he, therefore, requires a higher margin for his economic support. As a result the price to the consumer is higher. A rationality of the marketing process therefore implies an increase in the volume each trader or employee will handle and this can only be achieved by a greater specialization in the distribution chain. This has been proven in studies on the West African situation where the overall trade margin was lowest for frozen fish; the transport margin was lowest for frozen fish and stockfish and the retail margin was lowest for frozen fish and fresh fish. Dried products, including stockfish, required higher mark-ups, evidently because of low turnovers (Krone, 1970).

Pending further detailed investigations, it can tentatively be concluded that frozen fish offers certain advantages over fresh or dried fish as far as consumer appeal and distribution costs are concerned. However, well organized large-scale marketing systems, such as exist for stockfish, would probably result in lower costs and lower prices for other stable fishery products. The question is whether it is possible to organize traditional processing and marketing on a large scale or whether this would not require large-scale industrial processing at the same time.

## Outlook

It is expected that the contribution of frozen fish to the marketing of fish and fishery products in developing countries will increase. Under many conditions there are economies of scale and security of supplies to be obtained which cannot easily be realized through other products and systems. However, trading patterns of other products, notably dried fish, and opportunities for improving them should be studied before launching new investments in the field of frozen fish distribution. Apart from the techno-economic merits and disadvantages, the technological aspects of frozen fish distribution in the present unsophisticated form should be closely examined. It is likely that cost savings and operational improvements are possible and it is certain that, in the long term, product quality will have to be given greater attention. In many cases, there will be advantages in diversifying gradually into prepared products rather than ungutted whole fish. This trend can already be observed in some countries eg Cuba and Peru. Frozen fish, in portion size or filleted form, should be in particular demand in the institutional and catering trade, a sector which is likely to expand considerably in developing countries.

## References

**Krone, W.** (1970) Frozen fish marketing in West African countries. *FAO Fish. Rep.* No 96. 60pp.

**Krone, W. & Ruckes, E.** (1974) Export markets for fishery products from developing countries. In: *Fishery products* (ed R. Kreuzer) pp 371–377. Surrey, England: Fishing News (Books), 462 pp.

**FAO** (1975) *Yearbook of fishery statistics.* Vol 39. *Fishery commodities,* 1974.

# The exportation of frozen fish from a developing small-scale fishery

**S. Vidot and C. Ratcliffe**
Ministry of Agriculture, Fisheries and Food, Seychelles

## Summary

Seychelles provides a unique example of a non-specialized small-scale fishery which has been compelled to enter the export market at a very early stage in order to ensure its continued development.

This new industry is experiencing a variety of problems which relate not only to the country's geographical position but also to the lack of tradition and infrastructure at home as well as prevailing conditions in the importing countries.

The paper exposes some of the basic pioneering problems of the frozen fish export industry and concludes with assessments of the future outlook and potential.

## Résumé

Seychelles est un exemple unique de pêcherie artisanale non spécialisée qui a été incitée à participer au marché d'exportation à un stade très précoce de façon à assurer la poursuite de son développement.

Cette nouvelle industrie fait l'expérience d'une série de problèmes qui sont en relation avec la position géographique du pays mais également avec l'absence de traditions et d'infrastructures dans le pays ainsi que de conditions régnantes dans les pays importateurs.

Cet article expose certains des problèmes de l'industrie d'exportation du poisson congelé et conclut par les évaluations de perspectives des potentiels pour l'avenir.

## Resumen

Seychelles constituye un buen ejemplo de una pesquería a pequeña escala no especializada, la cual se ha visto obligada a entrar en el mercado de exportación en una fase temprana, para asegurar así su desarrollo continuo.

Esta nueva industria encuentra numerosos problemas, relacionados no sólo con la posición geográfica del país, sino también con la falta de tradición e infraestructura interior, así como con las condiciones vigentes en los países importadores.

El artículo expone algunos de los problemas primarios básicos de la industria de pescado congelado para exportación y concluye con la evaluación del potencial y perspectivas futuras.

## Introduction

The Seychelles archipelago consists of a scattered group of 86 granite and corralline islands in the western Indian Ocean. It has a land area of 280 km², spread over 400,000 km², and a population of approximately 56,000.

It is known (Cushing, 1971) that substantial stocks of pelagic and demersal fish species, capable of sustaining a sizeable export industry, exist in and around the archipelago. Until 1973, (apart from a short period in the sixties when a local fishing concern landed iced fish, stowed in coconut coir dust from off-shore banks) commercial fishing has been mainly confined to the fish trap and handline activities of a small fleet (currently estimated at 350) of 5–10 metre open boats landing fresh fish for home consumption from grounds generally within 50 km of the main islands.

Mahé, the largest and chief island, which has an area of 145 km² lies 1,500 km due east of Mombassa, 2,800 km south-west of Bombay and 1,100 km north of Madagascar. It is centrally situated along with the other granitic islands on a 27,000 km² plateau where the depth rarely exceeds 80 metres. In the past, the island suffered periods of acute seasonal fish shortage and the Government fisheries policy formulated in 1973 was primarily aimed at regularizing this situation. A secondary objective was the promotion of an export industry of pelagic species.

Victoria, the capital and only deep-water port, is on Mahé. It is the only town in Seychelles with a population of approximately 15,000. The newly formed export orientated off-shore artisanal demersal fishing fleet of 22 vessels, 10–14 metre in length, is based in the old port of Victoria.

In 1972, fish were not iced at sea and land-based freezing and frozen fish storage facilities were non-existent. Consequently, knowledge and experience of the basic fish handling practices associated with the storage of iced or frozen fish were absent in the local fishing industry. For many years the absence of cold storage facilties was thought to be the main constraint to fisheries development in Seychelles. However, the provision of these facilities was considered only in connection with holding buffer stocks of fish for sale on the local market during periods of acute shortage.

## Developments from 1973 to 1976

In January 1973 the first fish cold store (–20°C) of 15 tonne capacity was opened by a local fishing company. Handlining operations with five 10–12 metre traditional vessels commenced on grounds near the edge of the plateau 60–100 km from Mahé. The catches from four or five day trips (two or three fishing days) ranged from 800–1,500 kg per boat and mainly comprised large snappers (*Lutianus bohar, Lutianus sebae, Aprion virescens*) and rock-cods (*Epinephelus* spp.) of average weight 5 kg. The predominance of one particular species in the catch was directly related to the fishing location. At this time block ice became available at Rs75.00* per tonne from a newly opened brewery. Initially fish was stowed, as in the past, in a mixture of large chunks of ice and coconut coir dust and then washed in fresh water prior to cold storage.

The Fisheries Division incorporated a plywood fish box, insulated with polystyrene, on a traditional 28 ft open whale boat modified for research and development purposes. Following this example the company fitted large removable tailor-made insulated cases into the holds of their vessels. As a result of Government advice on handling and icing techniques, the coconut coir dust method was abandoned and the quality of iced fish on landing greatly improved. By the end of the year the pioneer company had erected a further 25 tonne cold room. A second company imported an ex-UK 16 metre MFV and opened a small iced and frozen fish retail business in Victoria market. Two new locally built (11 and 14 metre) vessels with insulated fish holds were put into commission.

The first year of off-shore activity coincided with increased and more regular landings from the gradually expanding inshore fleet and with relatively fine South East and North West Trade Wind seasons. This resulted in a limited demand for iced or frozen fish as the traditional fresh fish species which are more popular were readily obtainable. Thus when the cold stores were full the boats could not operate at maximum capacity. Fortunately the companies were able to cover their expenses by selling frozen stocks on the few occasions when bad weather conditions created shortages of fresh fish.

Faced with this lack of a local market the two companies began to explore the possibility of securing overseas outlets. Frozen specimens of different species, exported by a Seychellois businessman, were favourably received by a reputable fishing company and the Government was asked to grant permission for the exportation of a 5 tonne consignment. This was refused on the grounds that the fish in question were originally destined for local consumption and therefore not subjected to any measure of quality control. The shipment of such a large consignment, of a possibly inadequately prepared product, could have adverse effects on the future promotion of the export industry. There was considerable scepticism that fish, which had been handled so simply and had not been properly frozen, could find an overseas market. However, in view of the companies' plight and the favourable reception of the frozen specimens, permission was granted to ship a 100 kg non-commercial trial sample with a view to obtaining a detailed quality report. This sample received a clean bill of health and the importer reaffirmed the order for a 5 tonne consignment. The Director of Agriculture for Seychelles, who was present at the port of entry when the sample arrived, reported that the food inspector had been satisfied with its quality and expressed the view that visual inspection by an experienced person prior to shipment would, for normal purposes, give adequate assurance that future consignments would receive import clearance.

At this stage, the Government introduced the first of a series of conditions necessary for the issue of licences for individual consignments under the existing Fish Export Ordinance (applicable previously to the salt fish export industry).

The agreed conditions were:

(a) Licences should not be granted unless it was established that a surplus existed which could not be absorbed by the local market.

(b) Licences should not be issued unless the Fisheries Officers were satisfied, on visual inspection, that quality was up to the standard determined by prior trial consignments. The principle should be followed that export markets be tested with caution in order to prevent Seychelles' fish getting a bad name.

(c) Licences should be issued only to *bona fide* fishing companies capable of producing a product of the required quality.

(d) Licences should not be granted for the export of inshore reef fishes.

In order to establish adequate quality control standards for the long term it was agreed to secure the services of a handling, processing and marketing expert from TPI. It was also agreed to introduce interim control measures stipulating that fish destined for export must be:

(1) Cooled and stored by icing or other accepted refigeration methods aboard fishing boats.

(2) Transported from quayside to cold stores in insulated containers.

(3) Handled and stored in cold stores to the satisfaction of the Fisheries Officers.

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*1 Seychelles Rupee (Rs) = £ $^1/_{133}$ at June 1976.

(4) Packed for shipment in a hygienic manner and each container labelled with the exporters name and address.

(5) Transported from cold store to dock or airport in insulated containers.

Acting on advice from the Fisheries Division, the companies were now endeavouring to improve quality by paying more attention to their icing, handling and storage procedures. The fish were more adequately iced on board and pick-up vehicles were fitted with insulated containers. At the cold store, fish were frozen over a period of 24 hours before storage in an adjacent room at –20°C. The acceptance of the frozen product created a wave of enthusiasm and the first company involved started construction of its third cold room (30 tonnes capacity).

At this time the Government became concerned that regular exportation of large consignments would prejudice its aim to ensure adequate local supply and stipulated the retention of at least 20 per cent of the total frozen stock for the home market.

A 5 tonne consignment complying with the control measures was shipped in February 1974 and no adverse comments were made. A follow-up order for 20 tonnes was received together with enquiries from another country. With the limited cold storage space available it was necessary for the two companies to co-operate to meet the 20 tonne order. Prior to shipment, the Fisheries Officers rejected a 2 tonne lot of red snapper which had not been iced and was stored in a grocers cold room incapable of maintaining –20°C. Consequently only 18 tonnes of fish passed inspection for export. Again there was no adverse comment regarding quality but, as many of the plastic sacks used for packing were found burst on arrival, it was recommended that these be replaced by a stronger variety or, more ideally, by standard waxed cardboard fish boxes. The importing agent also requested that a 'fit for human consumption' certificate be provided to aid dealings with the importing country's health authorities.

Two-tonne consignments, purchased from one fishing company by a Seychellois middleman, were air-freighted on a weekly basis to the second country from February to November, when the operation terminated through financial problems. A 20 tonne consignment comprising three new orders sent in June received favourable comments and more orders were placed from both countries, but because of shipping cancellations the next consignment of 40 tonnes to the second country was not despatched until October.

In September, the Government leased a 20 tonne cold room and a 'quick freezing' room of 18.5m$^3$. This room which was designed to reduce 300 kg of iced fish to –30°C in 24 hours was situated in a new 300 tonne general cold storage establishment opened on Mahé in June 1974. It was originally intended to operate a 6 month pilot scheme to establish the economics of fish storage and marketing but instead the facilities were later subleased to the export concerns to provide additional freezing and storage capacity. Sceptical about the performance of the 'quick freezer' the Fisheries Division ran a 24 hour test with a 168 kg batch of average-sized fish. The resulting freezing curves showed that the temperature at the centre of these 4–5 kg fish was reduced to –20°C in 17–19 hours and that the temperature at the centre could never reach –30°C; the average time to pass through the thermal arrest period was approximately 8 hours. For quick freezing, the temperature at the centre of the fish must be reduced from 0 to –5°C (thermal arrest period) in no more than two hours. Therefore this 'quick freezing' room is not a quick freezer, nor does it meet its design specification.

By October the companies' limited catching, handling and storage facilities could not cope with existing orders. In an effort to increase production, the companies and speculative middlemen, who had appeared on the scene, encouraged other local boat owners, who were unfamiliar with proper icing and fish handling requirements, to fit insulated boxes on the understanding that the exporting companies would purchase the catches. With such an overall low level of experience it became doubtful whether the licensing conditions were being observed. As a result of the lack of suitable freezing facilities and the absence of properly insulated transport, one speculative middleman was caused considerable financial embarrassment when his 10 tonne consignment was rejected, in November 1974, by the shipping line inspector because its temperature was higher than the required –10°C. However, no adverse comments were received from the importing country.

In February 1975, with the assistance of the TPI handling and processing specialist, the Government introduced a non-statutory "Recommended Code of Practice for Icing and Freezing of Fish Destined for Export" stipulating that disregard of its recommendations could result in permission to export being refused.

Throughout 1975 it was possible to export only five consignments, totalling 135 tonnes. At a meeting with company representatives and boat owners in March 1975, the Government advised them to consider forming their own Central Marketing Agency. This could have resulted in a more rational development of export markets and a way of obtaining consignments large enough to warrant a shipping line making scheduled diversions of vessels to Seychelles. The idea was vetoed by the pioneer company who feared such a move would result in its losing control of the other operators. As a result of this short-sighted attitude, two businessmen present at the meeting formed a new company, took over the Government lease on the 20 tonne cold room and 'quick freezer' at the general cold storage establishment, and started operations with three vessels. Within a short time they had convinced the cold storage company of the need to provide additional facilities. The original 20 tonne fish storage space has now been increased to 80 tonnes and a further 100 tonne extension is proposed, a new 5 tonne per day blast freezer is in operation and a fish handling and packing room have been erected adjacent to the new facilities. The fishing company, which now owns seven vessels and manages a further eight vessels on contract, is aiming at an initial monthly production target of 80–100 tonnes. It is hoped that this will be sufficient to secure regular shipping services and obtain additional overseas markets. There are currently 22 vessels in the off-shore fleet and others are shortly to be commissioned.

Due to the absence of tradition in the frozen fish trade there is a paucity of back-up services and infrastructure. For instance, there are no proper refrigerated or insulated trucks on the island and frozen fish has to be transported from the cold stores to the quayside, in small quantities, in locally made insulated boxes loaded on the back of open trucks. In one extreme case the fish had to be transported in the fishing boats to the carrier ship which was anchored in mid-harbour. Obviously the whole loading process is, of necessity, slow even when the dockers are co-operative. To make matters worse, very little time is available for loading because imported frozen goods have to be cleared from the ships' refrigerated holds first; the holds are then allowed to obtain a sufficiently low temperature before receiving the fish. As mentioned previously, one consignment originating from a – 20°C store was rejected because dockside inspection by the ship's inspector revealed that the fish had warmed up to above –10°C during transit.

A further consequence of the lack of tradition and experience in Seychelles is that legislation does not exist for the regular inspection and certification of cold storage premises and fish handling establishments. This makes it difficult for Fisheries staff to persuade operators to maintain a high standard of hygience. No Government department is trained or equipped to implement a product quality control service and therefore it is not possible to issue authentic health certificates (to accompany export documents) which comply with various international standards. In fact, except for a few clauses in an antiquated ordinance relating mostly to the procedure for issuing or refusing export licences for fish generally, no statutory controls exist for this new trade. The exporters' good sense and co-operation, as well as the enlightened judgement of the Government fisheries authority, who certify the fish as being 'fit for human consumption', have been necessary to allow this trade to develop.

Although the local industry produces a high quality product from a simple inexpensive traditional fishing method, the exporters have to compete with lower prices being offered in other Indian Ocean ports for bulk trawl fish. The current minimum FOB price in Seychelles for assorted demersal species is Rs5/kg and the profit margin is very small due to the high operating and processing costs borne by the industry (no duty concessions on fuel and packaging materials exist, and electricity is expensive).

It is relevant to note that the traditional inshore handline fleet supplies the daily needs of the islands with un-iced fish. This fish is exposed to the sun in the bottom of open boats for many hours and can remain for up to four hours on the market stalls prior to being sold. Yet this fish, retailing at Rs2 to Rs4/kg, has been consumed and greatly appreciated by resident or tourist Europeans and other discerning expatriates in households and international hotels, sometimes after several weeks' storage in domestic-type freezers.

The composition of the catches presents a marketing problem. For instance, in one of the importing countries two of the species exported, namely *Lutianus bohar* and *Variola louti*, have in the past been responsible for outbreaks of ciguatera poisoning and are therefore generally suspect, irrespective of their origin. Fortunately no incidence of ciguatera has ever been reported in Seychelles, but the problem is nevertheless relevant in view of the possible future exploitation of more distant fishing grounds. Secondly, the markets so far established would prefer predominantly small fish, weighing approximately 1–2 kg (with head on), whereas the average weight of the snappers, rock-cods etc, caught by the local offshore boats, is about 5 kg. It is suspected that a modification of fishing gear or concentration on different grounds could produce small fish but, at the same time, of a different species composition. This was demonstrated during a joint handlinining exercise in June/July 1974 (Ratcliffe 1975), using lighter handline tackle with smaller hooks, which produced catches of 84% barefaces (lethrinids) and 16% red snappers (lutianids) and others (mainly 1–3 kg). It so happens that these same species predominant on the Seychelles banks at the moment offer the worst marketing prospects.

The geographic isolation of Seychelles is a handicap where shipping is concerned and the situation has become more acute since the re-opening of the Suez Canal. Most of the Indian Ocean maritime traffic previously routed around the Cape now by-passes Seychelles. To induce a major diversion through Port Victoria, the local exporters would need to offer either a very large consignment or pay a high freight premium. For the moment both alternatives are inconceivable due to the current low rate of production and low profit margin.

Although there has been a general increase in traffic over the last few years, shipping arrivals are still spasmodic. Ships are often substantially delayed, their itinerary is sometimes changed at very short notice and in some cases replaced by other vessels which are not suitably equipped to accommodate frozen cargo. Such snags invariably impose an element of financial embarrassment to fish exporters who, because of limited cold storage capacity ashore, have repeatedly been forced to curtail fishing activity.

These same exporters express an urgent desire to obtain regular connections with the Mediterranean and Western Europe. It is believed that, with very few exceptions, the countries in the Indian Ocean region are unlikely to become major fish importers because of restrictions on foreign exchange, the orientation of national fisheries development programmes towards international self-sufficiency etc. One of the importing countries has recently imposed a total ban on frozen fish importation from certain sources, including Seychelles, apparently with the aim of reducing competition with its own producers. Fortunately the quality of our fish was never questioned; indeed, negotiations for at least a partial lifting of the ban are now well advanced. Other potential buyers in Europe and West Africa have expressed interest provided relatively large consignments can be assured at regular intervals. However, the current limitations of the fleet and restricted cold storage facilities, not to mention the shortage of liquid capital, mitigate against meeting these requirements in the immediate future, even if prices were attractive and shipping were available.

## Conclusion

The pioneering problems outlined will hopefully be resolved with time. Nevertheless, in as much as some of them relate to the nature of the commodity, subjected in many countries to exacting and expensive standards of processing and storage, it is feared that unnecessary modernization may jeopardize the industry's very existence.

From the onset of the Seychelles frozen fish trade there have been no adverse comments regarding quality. In spite of the adoption of higher standards, the export price has remained static and increased production costs are being borne by the fledgling industry.

Whereas it was necessary to encourage the adoption of rigorous codes of practice, developed in advanced western societies for marketing structures mainly associated with large-scale fisheries, the authors believe that a reappraisal of standards, particularly as applicable to tropical fish species, would be opportune and that, for the sake of new export- orientated developing small-scale fisheries, a serious examination of the balance between the degree of sophistication and economics is urgently required. Had the authorities not been ready to take a calculated risk, knowing that many textbook rules were being bent or broken all along the line, development would have been hindered and it might have taken much longer for the beginnings of an export industry to be established.

## References

**Cushing, D. H.** (1971) *Survey of resources in the Indian Ocean and Indonesian area.* Rome: FAO, IOFC/DEV/71/2.

**Ratcliffe, C.** (1975) Offshore fishing in the Seychelles. In: *Oceanology International,* pp. 141–145. 1975 Conference 'Into Deeper Waters', Brighton, 16 March 1975. London: BPS Exhibitions.

# The UK market for frozen fish from tropical sources

**J. D. Walton**
International Fish Company Ltd, UK

### Summary

This paper considers the UK demand for fish from tropical areas. The demand is for whole frozen fish and is related largely to the immigrant population; as a result, it is unlikely to increase significantly in the future. Nevertheless, there are possibilities for potential exporters from tropical countries but there are problems associated with the entry into the UK market. These problems are associated mainly with packaging, presentation, transportation and import tariffs: the effect of these difficulties upon an exporter from a tropical country is considered. The size of the UK market for fish from the tropics is difficult to assess but is thought to be approximately 5000 tons per year.

### Résumé

Cet article étudie la demande du Royaume Uni en poisson provenant des zones tropicales. La demande concerne tout le poisson congelé et est largement en relation avec la population immigrante; en conséquence, elle ne risque pas d'augmenter de façon significative dans l'avenir. Néanmoins, il existe des possibilités pour d'éventuels exportateurs des pays tropicaux, mais il existe des problèmes liés à l'entrée dans le marché Britannique. Ces problèmes concernent essentiellement l'emballage, la présentation, le transport et les tarifs d'importation: l'effet de ces difficultés pour les exportateurs des pays tropicaux est étudié. L'importance du marché du poisson provenant des tropiques au Royaume Uni est difficile à préciser mais on peut penser que celui-ci est approximativement de 5000 tonnes par an.

### Resumen

El artículo considera la demanda de pescado procedente de zonas tropicales en el Reino Unido. Esa demanda se refiere al pescado congelado entero y está relacionada en gran parte con la población inmigrante. Como resultado, no es probable que experimente un aumento considerable en el futuro. Existen, sin embargo, posibilidades para los exportadores potenciales de países tropicales, pero la entrada en el mercado del Reino Unido es problemática. Los problemas están asociados principalmente con el envasado, la presentación, el transporte y las tarifas de importación. Se estudia el efecto de estas dificultades para los exportadores de países tropicales. Es difícil calcular el mercado del Reino Unido para pescado procedente de los trópicos, pero se considera aproximadamente de unos 5000 toneladas al año.

### Introduction

The market within the United Kingdom for tropical fish can essentially be divided into two sections; firstly, the various immigrant populations who have created a demand for the species of fish with which they are familiar in their countries of origin; secondly, from UK residents who have either in the course of their employment lived overseas or as a result of holidays have acquired a taste for the 'local fish' and welcome the opportunity to obtain these species in the United Kingdom.

Obviously, the trade is dependent on the immigrant populations and the growth in demand for tropical fish is directly related to the overall increase in the immigrant populations over the last few years. It is difficult to have an exact figure at any one given time bearing in mind that, in addition to those who are resident in the United Kingdom, one must also take into account those working temporarily or pursuing further education and the tourist population. It would be reasonable to presume, however, that one is looking at a market of about two million people whereas, of course, the UK resident market could only be measured in, at best, thousands if not, more accurately, hundreds. From this, it could be presumed that there is unlikely to be a further material increase in the number of potential customers in the foreseeable future and that to some degree this market has now been saturated.

### The market situation

At the moment, supplies are obtained from a wide range of countries, for example golden thread from China and Hong Kong, red snapper from Argentina, yellow croacker from the Caribbean, red mullet from Greece, to name but a few. For the purpose of this paper, I will not deal with the small quantities which are imported fresh as this does not amount to a significant quantity; it can be presumed that we are dealing exclusively with the frozen product and that, as the demand is for whole round fish (ie not gutted or dressed in any way), all species have been imported in this form since there is just no market for fillets or processed fish. This trade is now sufficiently well established that there is a definite pattern between the wholesalers/importers in this country and their sources of supply and, similarly, between the distributing and retail outlets. The trade runs smoothly on a consistent basis usually more than adequate to meet demands.

It may seem pessimistic not to be encouraging the producer nations to envisage a large growth potential in the United Kingdom but, unless the British people can be persuaded to radically change their habits, there is no possibility that this will be the case. In this context, the authorities in the United Kingdom will undoubtedly in the future be encouraging the public either to revert to species of fish such as mackerel and herring, which at the turn of the century (before the advent of the steam trawler) formed the major proportion of the fish eaten within the United Kingdom, or to accept new species of fish such as blue whiting as an alternative to the traditional types of white fish which, for a variety of reasons, may not be so readily available in the future. However, it would be irresponsible to suggest or imply that this could lead to a demand for tropical fish from the native UK population.

One point which should be stressed is that the growth in Chinese Restaurants and 'Take Away' shops and also Indian Restaurants, which has resulted in the enormous increase in demand for all types of prawns from temperate waters, has not resulted in a similar increase in the demand for tropical fish. Normally, tropical fish is not offered on the menu since there is no demand for it from the British customers and the fish is only purchased for feeding the restaurant staff.

Although, as has already been explained, the procurement and distribution of tropical fish within the United Kingdom is well established, this does not mean that importers are not interested in receiving offers from new sources of supply; unfortunately, would-be suppliers/producers are often at a disadvantage when compared to the established sources as they do not have similar facilities. In this context there are two essential criteria; the first is the availability of suitable packaging material to enable the product to be presented in an acceptable manner to the market (for example a carton containing between 20 and 50 lb is quite acceptable although, in the case of the larger unit, if this can be broken down into perhaps four bags, each weighing 12.5lb, this is obviously better than a 50 lb box unit); the second is the availability of regular freight opportunities for relatively small quantities of fish.

Here one has the problem of, for example, an isolated producer in the Indian Ocean who knows that the species of fish available are being marketed in the United Kingdom; he wishes to enter this market but, unless suitable packaging can be obtained and there are freight opportunities which will allow him to ship relatively small quantities on a regular basis, it will be extremely difficult to initiate the business. This is because shipping companies require a large inducement (probably a minimum consignment of 100 tons on a regular basis) to put vessels into new ports or to refrigerate holds of vessels already calling. However, UK importers, who may have an interest in seeing the fish from a new source, will obviously not be prepared to commit themselves to a large tonnage without first seeing small trial shipments. As with other commodities, importers are now thinking in terms of container loads whether this be the standard ship-borne container or a large refrigerated lorry giving a unit load between 12 and 15 tons.

The would-be exporter to the United Kingdom, who does not have access either to a regular conventional shipping service which can handle small parcels, or to a standard container service or to some form of overland refrigerated transport, is going to be at a disadvantage. The would-be exporter in a remote area is at a further disadvantage not only for the shipping of his produce but also for the procurement of the necessary packaging materials etc.

Another point which must be borne very much in mind is the question of import tariffs which will be payable on the fish. At the moment there are four rates of duty on fish coming into the United Kingdom; firstly, the rate levied on fish coming from the Common Market; secondly, a rate of duty on countries embraced under the heading 'ex-commonwealth'; thirdly, a rate on countries enjoying a special relationship with the European Economic Community; finally, the countries which are not covered by any of these areas, for example (in the context of tropical fish) the Argentine. As a basic rule of thumb, if the product can be obtained within the Common Market, there are normally tariff benefits (eg red mullet landed in Greece) and today the importer not only has to be aware of the various species of fish available from different areas but must also have a good working knowledge of the tariff structures and regulations issued by the authorities in Brussels.

### Concluding remarks

In closing, I recognize that some of you may consider I have been pessimistic but I would prefer to consider that I have in fact been realistic. Just looking at figures it might be possible to arrive at the conclusion that, with over 50 million people living in the United Kingdom, there should be an enormous growth potential for tropical fish, particularly as supplies from traditional sources may become scarcer coupled with the fact that the world demand for all types of foodstuffs is undoubtedly increasing; I doubt that this will be the case. Whilst importers in this country will continue to do all possible to develop their outlets, it is most unlikely that the total tonnage of tropical fish sold in the United Kingdom will materially increase from about 5000 tons per annum. While I am confident that this figure is reasonably accurate, I must stress that it was not taken from an official source; I arrived at it from my own calculations and from discussions with colleagues in the trade. Unfortunately, and I must stress I am in no way being critical, the figures produced by the authorities tend to be on a country to country basis and are not broken down into all species, it is therefore extremely difficult to make a detailed analysis. One final word, despite the realism stated above, I would not want anyone present to go away with the impression that suppliers will receive anything but a sympathetic hearing from the trade as a whole in the United Kingdom. In fact, from personal experience, I would say that the importers and wholesalers of these new species of fish are amongst some of the most forward looking people in the industry, are certainly interested in developing their trade wherever possible and, even if this sadly does not prove easy or practical, will always have the time and interest to listen to whatever proposals may be made to them. I can only wish all would-be suppliers the very best of luck in their endeavours.

# Frozen fish marketing in Nigeria

**S. O. Talabi and C. F. Makanjuola**
Nigerian Institute for Oceanography and Marine Research, Nigeria

## Summary

The present levels of production and importation of frozen fish into Nigeria are described together with the post-landing operations of frozen fish handling. The features of frozen fish marketing, especially in respect of price structure, technology aspects in designs of cold stores and shops for wholesale and retail marketing, and levels of operations are also presented. The quality aspects of frozen fish distribution, retail marketing and storage are assessed and an economic comparison is made with fresh fish marketing. Future developments, as inferred from the National Plan on Fisheries Projects, are also considered.

## Résumé

Les niveaux actuels de production et d'importation de poisson congelé au Nigeria sont décrits ainsi que les opérations, après débarquement, de manipulation du poisson congelé. Les caractéristiques du marché du poisson congelé, en particulier en ce qui concerne le niveau de prix, les aspects technologiques des installations de chambres froides et de magasins pour le commerce de gros et de détail et les différents stades de ces opérations sont également présentés. Les aspects concernant la qualité de la distribution du poisson congelé, la commercialisation et le stockage au détail sont précisés et une comparaison du point de vue économique est faite avec la commercialisation du poisson frais. Les prévisions de développement pour l'avenir ainsi qu'elles sont établies par le Plan National des Projets pour la Pêche sont également examinés.

## Resumen

Se describen los niveles actuales de producción e importación de pescado congelado en Nigeria, junto con las operaciones de manipulación del pescado congelado posteriores a la descarga. Se estudian también las características de la comercialización del pescado congelado, especialmente en relación con la estructura de los precios, los aspectos tecnológicos de los diseños de los almacenes frigoríficos y establecimientos para la venta al por mayor y al por menor, y los niveles operacionales. Se hace una valoración de los aspectos cualitativos de la distribución del pescado congelado, la commercialización al por menor y el almacenamiento, así como una comparación económica con la comercialización del pescado fresco. Se considera también el desarrollo futuro, según conclusiones del Plan Nacional de Proyectos Pesqueros.

## Introduction

In preparing a paper on the marketing of frozen fish in Nigeria, the authors were faced with the problem of deciding where emphasis should be laid. This is not to say that the system is so complicated that each component can form the basis of a separate treatise, it is simply that the general features have been well documented by Krone (1970). We therefore set out to update figures and procedures where necessary. It is hoped that fishery development personnel from other areas of the developing world will be able to contribute their experience in this area during the discussion.

## The commercial fishery

Nigeria's frozen fish comes from three major sources; distant-water fishing, inshore fishing and direct importation.

As a result of extensive fishery surveys by the Federal Government of Nigeria, it is now possible to describe the economic activities in the fishery sector. Thus in Table 1 the structure of the Nigerian commercial fishery is presented. It should be noted that the high figure recorded for the expatriate staff is due to the fact that many of the shrimping vessels belong to the 'joint

TABLE 1. *Structure of commercial fishery in 1975*

| *Type of fishing* | *No of vessels* | *Cost of vessels (₦* x $10^3$)* | *No. of staff* | | *Cost of gear (₦ x $10^3$)* | *Average gross tonnage of vessel* | *Average overall length of vessel (metres)* | *Average life of vessels (years)* | *Output* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | *Fish* | | *Prawns* | |
| | | | *Expatriate* | *Nigerian* | | | | | *Quantity (tonnes)* | *Value (₦ x $10^3$)* | *Quantity (tonnes)* | *Value (₦ x $10^3$)* |
| Inshore fishing | 31 | 376.15 | 7 | 409 | 94.79 | 58.72 | 17.11 | 10 | 4,146.20 | 2,943.80 | 82.9 | 31.59 |
| Inshore shrimping | 30 | 3,509.18 | 102 | 484 | 342.40 | 144.12 | 27.31 | 10 | 4,300.46 | 1,333.14 | 2,185.06 | 4,372.30 |
| Domestic production | 61 | 3,885.33 | 109 | 893 | 437.19 | – | – | – | 8,446.66 | 4,276.94 | 2,267.96 | 4,403.89 |
| Distant-water fishing | 72** | 12,283.20 | 19 | 147 | 1,400.00 | 2,129.30 | 82.76 | 17.5 | 113,443.60 | 29,268.45 | 370.9 | 72.33 |
| *Total* | 133 | 16,168.53 | 128 | 1,040 | 1,837.19 | – | – | – | 121,890.26 | 33,545.39 | 2,638.86 | 4,476.22 |

* I Naira (₦) = £0.8 at June 1976.

** Distant-water fishing vessels are operated on a charter basis, 105 were licensed to land fish, whereas only 72 actually landed fish in 1975.

Source: Federal Department of Fisheries, Nigeria, 1975.

TABLE 2. *Summary of commercial fishery (1975)*

| *Type of fishing* | *Number of vessels operated* | *Capital cost (₦ × $10^3$)* | *Operating cost (₦ × $10^3$)* | *Landing cost fish/prawns (₦ × $10^3$)* | *Value of landings (₦ × $10^3$)* |
|---|---|---|---|---|---|
| Inshore fishing | 31 | 470.94 | 1,308.40 | 4,229.10 | 2,975.39 |
| Inshore shrimping | 30 | 3,851.58 | 3,919.45 | 6,485.52 | 5,705.44 |
| Domestic production | 61 | 4,322.52 | 5,227.85 | 10,714.62 | 8,680.83 |
| Distant-water fishing | 72 | 13,683.20 | 10,368.74 | 113,414.50 | 29,340.78 |
| *Total* | 133 | 18,005.72 | 15,596.59 | 124,129.12 | 38,021.61 |

TABLE 3. *Operating cost of commercial fishery by type of fishing (Naira x $10^3$)*

| *Item* | *Shrimping* | *Inshore fishing* | *Distant water fishing* | *Total* |
|---|---|---|---|---|
| Food on board | 205.89 | 56.02 | 102.89 | 364.19 |
| Fuel, lubricants | 845.86 | 288.00 | 385.60 | 1,519.46 |
| Ice and icing | – | 59.76 | 24.60 | 84.36 |
| Maintenance, repair of vessels | 104.27 | 49.25 | 272.00 | 425.15 |
| Transport cost and vehicle maintenance | 75.05 | 29.89 | 513.96 | 618.92 |
| Electricity | 45.38 | 26.78 | 481.45 | 553.61 |
| Bank charges | 217.74 | 0.72 | 1,059.44 | 1,277.91 |
| Insurance premium-vessels | 151.37 | 8.86 | 312.00 | 472.23 |
| Professional fee | 91.26 | 0.30 | 162.92 | 254.50 |
| Rents, residential | 28.60 | 6.00 | 280.35 | 314.95 |
| Rents, non-residential | 30.08 | 1.20 | 161.23 | 192.51 |
| Telephone and postal charges | 6.00 | 1.20 | 95.26 | 120.46 |
| Depreciation of vessels | 735.52 | 79.00 | 320.00 | 1,134.50 |
| Commission and other allowances | 17.28 | 14.02 | 1,004.44 | 1,035.69 |
| Contribution to N.P.F. | 4.58 | 2.57 | 54.30 | 61.46 |
| Staff insurance | 36.80 | 7.20 | 525.28 | 569.28 |
| Wages and salaries | 788.00 | 676.63 | 3,681.34 | 5,145.99 |
| Other expenses | 535.77 | 1.00 | 932.29 | 1,469.06 |
| *Total* | 3,919.45 | 1,308.40 | 10,368.74 | 15,596.59 |

ownership group' with the foreign counterpart providing the technical know-how. It is equally noteworthy that a large proportion of the fish landed is from the distant-water operations. The operating costs, value of landings etc are also presented in Table 2; and Table 3 refers to the operating costs of the different types of commercial fishery.

The shrimp by-catch represents a potentially important resource but at present only sizeable fish, that will command a good price and justify storage costs, are landed. Thus in 1975, production by inshore fishing and shrimping vessels was as shown in Table 4. The composition of the catch from distant-water vessels is shown in Table 5.

Frozen fish in Nigeria normally originates from these major fisheries, consequently the fish are usually widely scattered and diversified and often represented by a conglomeration of local and exotic fish species.

Pre-landing operations are essentially the same as those of the industrialized fishing industries of the world.

## The marketing system

Marketing begins as soon as the vessel lands the fish, and the post-landing operations constitute an essential part of the marketing system. A number of factors influence the intensity and efficiency of these operations. These include the location of the cold stores and markets in relation to the unloading quay. Some fishing companies such as Ibru Seafood Limited and Eko Nippon have direct access to docking facilities, where their cold stores are situated, but many others, such as Globe, Universal etc, discharge at rented wharfs.

TABLE 4. *Production by inshore fishing and shrimping vessels in 1975*

| *Fish species* | *Quantity (tonnes)* |
|---|---|
| Croaker, large | 159.26 |
| Croaker, small | 1,663.75 |
| Ray | 71.46 |
| Sole | 117.07 |
| Shark | 76.15 |
| Threadfin | 70.88 |
| Catfish | 146.57 |
| Bigeye | 242.80 |
| Spadefish | 49.54 |
| Grunter | 63.50 |
| Moonfish | 1,173.50 |
| Miscellaneous* | 5,612.18 |
| Prawns | 2,267.96 |
| *Total* | 10,714.62 |

*Mixed fish landed by shrimpers, turtle and other shellfish except prawns

TABLE 5. *Summary of distant-water landing (by species) in 1975*

| *Species* | *Quantity (tonnes)* |
|---|---|
| Bream | 5,992.0 |
| Horse mackerel | 53,740.5 |
| Spanish mackerel | 5,756.6 |
| Mackerel | 30,521.9 |
| Hake | 1,964.1 |
| Sole | 133.1 |
| *Sardinella* | 11,488.4 |
| Croaker | 8.2 |
| Cutlassfish | 1,002.8 |
| Yellow jack | 0.5 |
| Red snapper | 188.9 |
| Grey snapper | 555.4 |
| Tersergal | 30.5 |
| Bluefish | 1.0 |
| Caranx | 41.9 |
| Red fish | 31.3 |
| Lufar | 10.0 |
| Zuban | 71.9 |
| Catfish | 21.2 |
| Skumbia | 60.0 |
| Herring | 2.0 |
| Prawns | 370.9 |
| Mixed | 1,821.4 |
| *Total* | 113,814.5 |

### *Off-loading*

In order to facilitate effective off-loading and landing operations, a variety of technical facilities are provided with the sole objective of maintaining the quality of the fish as it moves through the marketing system. The boxed or cartoned fish (usually ranging between 20 and 30 kg) are moved from the fish holds to the cold stores or refrigerated trucks either by chains of labourers or by means of manually or mechanically powered winch and roller systems.

The degree of mechanization varies from company to company. For example, Osadjere Fishing Company and Ibru Sea Foods Limited adopt totally manual systems, using a chain of labourers. These men are distributed from the fish hold on board the trawler to the refrigerated or insulated trucks. The men, wearing insulated jackets and gloves, pass the fish boxes from hand to hand. Eko Nippon adopts a combination of roller-manual system and less frequently the motor driven conveyor belt and the winch systems.

The off-loaded fish boxes are either arranged in the cold room immediately or if they do not have storage facilities on the quay, the boxes are loaded into trucks for transport to the companies' main cold stores.

### *Distribution channels*

A clearly defined system or network of frozen fish distribution exists through a chain of intermediaries who handle products at different levels. Cartoned fish are marketed either directly after off-loading from the vessel or after a period of storage in the cold rooms, which are usually maintained at between −8 and −12°C. As soon as the product enters the distribution channel, it exchanges hands a number of times until the retail stage, when it is sold to the consumer.

The length of the distribution channel varies from company to company with the variation arising at the traditional marketing level. There is a common pattern of distribution, characteristic of products passing through clearly defined intermediaries (termed agents) before they enter the traditional channels. The fishing company (or importer) sells direct to its 'factors' and commissioned agents. Factors are either shareholders in the company or businessmen who are required to deposit money with the fishing company as security even though they operate on a commission basis. The companies make regular deliveries to cold stores/depots which they help to establish in interior towns and villages and from which factors sell to their agents, who are registered wholesalers. Commissioned agents make cash purchases from the company at the main cold stores and receive commission at a specified rate per carton of fish.

Beyond this level, the product enters the traditional channels over which the companies have no control. Retailers make cash purchases from the registered wholesalers, although they may also deal direct with commissioned agents or with factors at the out-station depots. It is characteristic of frozen fish retailing that the retailers bear the cost of transporting their fish to the retail market. The sole distributors at the retail level are women. They monopolize the marketing of frozen fish by employing traditional means and by operating through powerful organizations. Since only registered members of these organizations have the right to participate in the frozen fish retail trade, it follows that the vices of the trade, once agreed upon by the organization will continue indefinitely on the market. This is not to say that the distribution network at the traditional level is clearly defined or identified. Thus, the products change hands as many times as decided by the retailers operating in each company and area. For instance, observations at Osadjere and Ibru have revealed that the products change hands only twice before reaching the ultimate consumer in the traditional channel. Globe Fish appears to be the same while at the Eko Nippon Company, two sets of retailers have been identified.

### *Pricing*

Fishing companies determine the prices at which fish are sold to their agents and factors. These prices are usually fixed but there is some flexibility to allow for changes in the marketing conditions (eg supply and demand) at different seasons. Prices are differentiated according to species, weight, size of cartons and the source of supply, which may vary from company to company. It is noteworthy that each company specializes in the importation of certain species, although some species are generally imported by most of them. For example, mackerel, horse mackerel and lady fish are imported by most companies. Rare species such as catfish and sole sell at higher prices than the usually available species like mackerel and lady fish (*Albula* sp.). For instance, while a 30 kg box of catfish sells for ₦14–15, the same weight of mackerel sells for ₦9–10.50. Table 6 illustrates the price variations with product size and carton size.

The prices at which the commissioned agents or registered wholesalers retail fish should be the same as the company's price, since the wholesalers are selling on behalf of the company. However, what generally happens is that the wholesaler sells at prices approximately ₦0.50–1.00 higher than the company's posted price, and this is to be regarded as their extra profit.

The determination of retail prices is a very difficult task. Huge profits and losses are often incurred. Several factors influence the prices of the fish in the retail market, these include: demand for the particular fish; flexibility of shift in demand, preferences and substitution between meat and fish; religious factors; distance from the sub-depot; the month of the year; and location of the market in terms of income level of inhabitants. The overall price of the commodity is determined by an interplay of all these factors.

In comparing the retail markets (Tables 7 to 10) it will be seen that the prices fluctuate widely. Obalende and Sandgrouse markets are quite close to the sea but are rather less accessible than Oyingbo and Tejuoso markets because of the traffic congestion in Lagos. While this could have produced the lower price of a few of the fish, consumer income distribution also appears to be a very strong factor. As mentioned earlier, pricing philosophy at the retail level is very difficult to establish and one can only state that the basis for the pricing policy is to make the maximum profit. This comes clearly to light when the posted, wholesale prices are compared with the mean of prices collected for three months (Table 11).

TABLE 6. *Typical prices of frozen fish sold by fishing/importing companies to agents (Naira)*

| *Type of fish* | *Small fish* | | *Large fish* | |
|---|---|---|---|---|
| | *20 kg cartons (₦)* | *30 kg cartons (₦)* | *20 kg cartons (₦)* | *30 kg cartons (₦)* |
| Mackerel | 8.00 | 9–9.50 | 8–9.00 | 10.50 |
| Lady fish | 10.00 | 11–12.00 | 10–11.00 | 12.00 |
| Catfish | – | – | 14.00 | 15–15.50 |
| Silverfish | 9–10.00 | 10–11 | 11–12 | 13–14 |
| Mixed | – | – | 9 | 10 |

TABLE 7. *Obalende Market: frozen fish retail prices (Kobo)**

| *Local name* | *English common name* | *Biological name* | *Price/kg March (k)* | *Price/kg April (k)* | *Price/kg May (k)* |
|---|---|---|---|---|---|
| Owere | Pampano | *Lichia trachinotus* | 102 | – | – |
| Kote | | *Scomber japonicus* | 80 | 68 | 90 |
| Lady fish | Lady fish | *Albula* sp. | 97 | 125 | 94 |
| Ikekere | Grunter | *Pomadasys* sp. | 89 | 75 | – |
| Igbakere | Red snappers | *Lutjanus* sp. | 80.7 | 83 | – |
| Abuku | | | 58.8 | – | – |
| Paula | Stockfish | | – | 73 | 83.3 |
| Monkere | Mackerel | *Carangi scyris* | 52 | 55.5 | 65 |
| Titus | | | – | 88.9 | 78.9 |

* 100 Kobo = 1 Naira

TABLE 8. *Sangrouse Market: frozen fish retail prices (Kobo)*

| *Local name* | *English common name* | *Biological name* | *Price/kg March (k)* | *Price/kg April (k)* | *Price/kg May (k)* |
|---|---|---|---|---|---|
| Atoko | Mullet | *Mugil falcipinniz* | 73.8 | 86.2 | 100.0 |
| Oko | Grouper | *Serranicus epinephelus* | 87.5 | 103.0 | – |
| Monkere | Mackerel | *Scomber japonicus* | 58.8 | 54.17 | – |
| Eipya | Tilapia | *Tilapia* sp. | 66.7 | 87.0 | – |
| Titus | Titus | | – | 71.0 | 63.0 |
| Lady fish | Lady fish | *Albula* sp. | 58.8 | 71.4 | 111.0 |
| Ikekere | Grunter | *Pomadasys* sp. | – | 80.0 | – |
| Awo | Drums | *Sciaenius larimns* | 90.0 | 100.0 | – |
| Abo | Sole | | 150.0 | – | – |
| Oje | Silverfish | *Trichiuris leptusus* | 118.0 | 115.0 | – |
| Bluefish | Bluefish | *Pomatomus saltatiris* | 86.5 | – | 122.0 |
| Panla | Stockfish | | 100.0 | 71.4 | 76.9 |
| Owere | Pampano | *Lichia trachinotus* | 76.9 | 100.0 | – |
| Kote | | | – | 74.1 | 89.3 |

TABLE 9. *Oyingbo Market: frozen fish retail prices (Kobo)*

| *Local name* | *English common name* | *Biological name* | *Price/kg March (k)* | *Price/kg April (k)* | *Price/kg May (k)* |
|---|---|---|---|---|---|
| Atoko | Mullet | *Mugil falcipinniz* | 68.5 | 83.3 | 91.0 |
| Owere | Pampano | *Lichia trachinotus* | 97.6 | 103.0 | 105.0 |
| Oko | Sea perches | *Serranicus epinephelus* | 83.3 | 121.0 | 125.0 |
| Monkere | Mackerel | *Carangi scyris* | 57.1 | 71.4 | 63.0 |
| Bluefish | Bluefish | *Pomatomus saltatrix* | 118.0 | – | 106.0 |
| Epiya | Tilapia | *Tilapia* sp. | 78.1 | 80.6 | – |
| Lady fish | Lady fish | *Albula* sp. | 69.4 | 75.0 | 118.0 |
| Titus | Titus | *Sardinella* sp. | 60.0 | 64.3 | 65.0 |
| Ikekere | Grunters | *Pomadasys* sp. | 100.0 | 80.0 | – |
| Panla | Frozen stockfish | | 109.0 | 100.0 | 115.0 |
| Kote | | | – | 130.0 | 105.0 |
| Ajakun | | | – | – | 250.0 |
| Oje | Silverfish/Cutlass-fish | *Trichiuris lepmrus* sp. | 90.0 | – | 83.0 |

TABLE 10. *Tejuoso Market frozen fish retail prices (Kobo)*

| *Local name* | *Common english name* | *Biological name* | *Price/kg March (k)* | *Price/kg April (k)* | *Price/kg May (k)* |
|---|---|---|---|---|---|
| Atoko | Mullet | *Mugil falcipinniz* | 83.3 | – | – |
| Oko | Grouper | *Serranicus epinephelus* | 89.3 | 144.0 | – |
| Monkere | Mackerel | *Scomber japonicus* | 58.8 | 60 | 67.0 |
| Epiya | Tilapia | *Tilapia* sp. | 68.2 | – | – |
| Titus | Titus | *Sardinella* sp. | 89.3 | 60.6 | 68.0 |
| Lady fish | Lady fish | *Albula* sp. | 65.2 | 71.4 | – |
| Ikereke | Grunters | *Pomadasys* sp. | – | – | – |
| Awo | Drums | *Sciaenius larimus* | 83.3 | 130.0 | – |
| Abuku | | | 104.0 | – | – |
| Kote | | | – | – | – |
| Oje | Cutlassfish/ Silverfish | *Trichiurus* | – | – | 111.0 |
| Panla | Frozen stockfish | | – | – | 100.0 |

TABLE 11. *Mean retail prices of frozen fish sold at the four selected Lagos markets during the three month period March–May and computed wholesale prices (Kobo)*

| *Local name* | *Wholesale price/kg (k)* | *Obalende (k)* | *Sangrouse (k)* | *Oyingbo (k)* | *Tejuoso (k)* |
|---|---|---|---|---|---|
| Atoko | – | – | 86 | 81 | 83 |
| Epiya | – | – | 76 | 79 | 68 |
| Ikekere | – | 82 | 80 | 90 | – |
| Owere | – | 102 | 89 | 102 | – |
| Monkere | – | 57 | 56 | 64 | 62 |
| Lady fish | 50–60 | 105 | 80 | 87 | 68 |
| Kote | – | 79 | – | 117 | – |
| Abo | 46–50 | – | 105 | – | – |
| Oje | 100 | – | 116 | 86 | 111 |
| Awo | – | – | 95 | – | 106 |
| Igabakere | 40 | 82 | – | – | – |
| Oko | – | – | 95 | 110 | 116 |
| Bluefish | – | – | 104 | 112 | – |
| Titus | – | 83 | 67 | 63 | 72 |
| Panla | – | 78 | 83 | 108 | 100 |

Outside Lagos, the picture becomes even more confusing. One or two frozen fish are slightly cheaper in Ibadan (139 km from the fishing port). It is difficult to explain why this should be so. Generally speaking, retail prices in Ibadan are much higher than in Lagos and again exhibit variations between markets in the same town.

Beyond the commissioned agents level, the company has no further say or control over the price structure. The agents, apart from obtaining commission from the companies generally sell to sub-agents at a profit. These in turn sell to retailers at a profit. By the time the product reaches the consumer, the calculated price per carton has risen greatly as shown in Table 11.

### *Profit margins*

In determining the profit margins, therefore, the different entities involved in the distribution, ie the fishing company, wholesaler and retailer, have to be considered separately. In computing profit margins apart from considering the difference between the selling and purchase price, expenses incurred before the sale of the fish have also to be taken into account. For instance, capital cost on inshore (general) fishing for 1975 was calculated as ₦470,940 while the operating cost was ₦1,308,400 for 31 vessels (Table 3). The capital cost per vessel in this cateogry of fishing was therefore ₦15,190 and the operating cost was ₦42,206. The value of landing per vessel was ₦95,980; value assessment being based on direct sale without further processing. The net profit was ₦30,584. With sufficient data collected on the operational expenses and capital outlays of fish importing companies, the net profit can likewise be computed.

The wholesale profit is more easily calculated since little or no expense is incurred. Indeed, the wholesalers profit margin is the difference between the companies posted price and the price at which the fish is sold to retailers, plus his commission from the fishing/importing company.

Retailers' profit margins are more complicated. Since the retailer arranges to transport his/her fish to the retail market, she bears some transportation expenses. Furthermore, loss by theft, accidents and through spoilage have to be taken into account. Since the storage facilities in retail markets are poor, if the retailer does not sell all his/her product in the early hours of the morning, rapid thawing, resulting in drip loss and general deterioration, forces her to sell out at a reduced price. While the company's and wholesaler's profit may fluctuate within narrow ranges, that of the retailer is uncertain and therefore can hardly be predetermined.

### Fresh fish

Fresh fish is generally more expensive than frozen fish in Nigeria (see Tables 12 and 13). When these figures

TABLE 12. *Sangrouse Market: fresh fish retail prices (Naira)*

| *Local name* | *English Common name* | *Biological name* | *Price/kg March (₦)* | *Price/kg April (₦)* | *Price/kg May (₦)* |
|---|---|---|---|---|---|
| Atoko | Mullet | *Mugil falcipinniz* | 2.75 | 2.89 | 2.34 |
| Obokun | Catfish | *Clarius heterobranchus* | 6.00 | 5.60 | 6.00 |
| Ikekere | Grunters | *Pomadasys* sp. | 2.50 | 2.50 | 2.31 |
| Abo | Tongue sole | *Cynoglossus* sp. | 2.50 | 2.00 | 2.35 |
| Apo | Croaker | *Pseudotolithus senegalensis* | 1.50 | – | 1.33 |
| Igbakere | Red snapper | *Lutjanus* sp. | 2.80 | 2.27 | – |
| Epiya | Tilapia | *Tilapia* sp. | 3.50 | – | 4.82 |
| Owere | Pampano | *Carangida trichinotus* | – | – | 1.83 |
| Efun | Shiny-nose | *Polydactylus* p. | – | – | 3.00 |
| Igun | Ten pounder | *Elops* sp. | 1.50 | 1.31 | – |

TABLE 13 *Oyingbo Market fresh fish retail prices (Naira)*

| *Local name* | *English common name* | *Biological name* | *Price/kg March (₦)* | *Price/kg April (₦)* | *Price/kg May (₦)* |
|---|---|---|---|---|---|
| Atoko | Mullet | *Mugil falcipinniz* | 2.50 | 2.94 | 2.88 |
| Obokun | Catfish | *Clarius heterobranchus* | 6.30 | 6.50 | 5.20 |
| Ikekere | Grunter | *Pomadasys* sp. | 2.00 | 2.25 | 2.03 |
| Igbakere | Red snapper | *Lutjanus* sp. | – | 2.08 | – |
| Abo | Sole | *Synoglossus* sp. | 2.00 | 2.50 | 1.67 |
| Oko | Sea perches | *Serranicus epinephelus* | 3.40 | 3.14 | 2.50 |
| Awo | Drum | *Sciaenius larimus* | – | 2.98 | – |
| Epiya | Tilapia | *Tilapia* sp. | 5.00 | 4.63 | – |
| Apo | Croaker | *Pseudotolithus senegalensis* | 1.80 | 1.50 | 1.76 |
| Ofon efun | Shiny-nost | *Polydactylus* sp. | – | 3.47 | – |
| Kote | | | – | – | 1.98 |

are compared with the retail prices for frozen fish at Table 11, the findings of Lagoin and Saluwu (1967) (reproduced by Krone 1970) that fresh fish is normally more expensive than frozen fish, appear to remain valid. However, in Nigeria, there are still the problems of efficient fresh fish storage, transportation and marketing in certain areas of tremendous fish production. In these parts, there is no demand for frozen fish at all and no price will be placed upon it.

### Technological aspects of frozen fish marketing

The essential technical facilities for freezing of fish are very similar to those of the industrialized nations. Since several of the frozen fish marketing companies have foreign partnerships, the technologies of the foreign countries are generally transferred to Nigeria. Fortunately, no serious error has been made so far in technical specifications. Storage facilities are provided at the port of landing and are usually large cold stores (−12°C) with capacities of up to 450 tonnes of frozen fish. Such large stores are found in Lagos and Port Harcourt. Most refrigeration plants in the Nigerian fish trade use freon as refrigerant and are fitted with air-cooled condensers. The use of cold air barriers to prevent heat leakage into the cold room is also becoming popular.

Apart from the precautionary measures, taken at the fishing port, to maintain frozen fish at low temperatures, fishing companies also operate a chain of refrigerated vehicles and insulated trucks for transportation of frozen fish to the inland depots and, in some cases, to the retail shops and markets. These trucks are locally made and range from 5–10 tonnes capacity. However, the precautionary measures taken by the companies to conserve the good quality of the fish cease as soon as they are sold to the commissioned agents. This group of business entrepreneurs receive the product direct from the cold stores and display it on tables or slabs; often exposed to the air and the high ambient temperature. Also, as a result of the careless handling by both the store labourers and agents, the cartons and boxes are usually torn thereby exposing the fish which may or may not be intact.

The retailers who further handle the frozen fish do so without any regard for its quality . They transport the fish mainly by taxis or lorries which are not insulated. It is a common characteristic of retail markets to lack cold stores or refrigerated rooms. Fish are almost always displayed either singly or in small numbers, on slabs or tables exposed to the sun.

Technological measures aimed at improving frozen fish marketing in Nigeria must concentrate on the retailers, their practices and their tools.

### The economic and social implications of frozen fish marketing

The rapid expansion of the frozen fish industry has had a notable impact, both economically and socially, on the economy of the country and on the general public at large.

Frozen fish distributed and marketed in the country are partly foreign in origin. They are obtained mainly from distant-water vessels owned by nations such as Japan, Poland, USSR, The Gambia and Senegal, and operated under charter arrangement with Nigerian fishing companies. To effect transactions with these countries the importing companies have to obtain foreign exchange allocations from the Federal Government. It, follows therefore, that a large part of the country's foreign exchange earnings is spent on the importation of fish for domestic consumption. This has an adverse effect on the economy of the country and is disturbing when one considers the abundant fishery resources with which Nigeria is endowed.

The capital investments by the fishing companies, in terms of cold stores and other essential marketing facilities, constitute a drain on the national economy since the raw materials are mainly imported. Also the few companies engaging in direct fishing in Nigerian waters purchase freezer trawlers and engage expatriate crews, all paid in foreign exchange.

Apart from the adverse economic factors, frozen fish marketing operates to the detriment of the indigenous fishing industry. It is, however, commendable that this supply of fish has been reliable as a major source of animal protein to the public. It has made a social impact by raising the generally low protein consumption level, which the livestock and the indigenous fishing industry have not been able to raise substantially.

Because the frozen fish industry provides this alternative source of fish supply, is viable and profitable, the public and government have, in the past, neglected the indigenous fishing population. Rather than modernize the artisanal fishery, which is characterized by small-scale production from canoes, efforts have been concentrated on the expansion of frozen fish importation, distribution and marketing. Such efforts include the removal of import duties on imported fish. It is important to mention that this is not a calculated effort to frustrate the indigenous fishermen. It was a short-term measure adopted to off-set the present shortage in the supply of animal protein in the country. While the government regards this as a short-term measure, it should not relax in its efforts towards the expansion and modernization of the indigenous industry.

Although the frozen fish industry has had a tremendous impact on the level of protein consumption in the country, it has not expanded to the inland districts. The products, as of now, are not always distributed beyond the villages outside the big cities; this could partly be attributed to communication and infrastructural problems.

Commenting on the efficiency of the marketing system itself, it is essential to note that the mechanics of marketing, the provision of facilities and the essential marketing functions of wholesaling, retailing, packaging, processing and transporting all contribute towards the economic status of the system. Inefficiency, lack of essential facilities, non-equitable and steep fluctuations in supply and prices, and product wastages are common characteristics of the present system of frozen fish marketing. The length of the distribution network through the several agents is uneconomic and has contributed to inefficiency in the marketing system. These characteristics, coupled with the lack of essential facilities, result in wastages, recorded as between 15 and 20% each year. The fluctuation in supply has resulted in consequent fluctuation in prices which do not favour consumers, the majority of whom are in the low income level. Poor handling and lack of essential facilities result in poor quality products presented for sale; this is detrimental to public health.

In addition to the economic implications of frozen fish marketing, there are some social implications worth mentioning. As mentioned earlier, the appreciable impact of frozen fish marketing on the level of protein consumption in the country is highly commendable. Were it not for the frozen fish supply, the present condition of supply would be far short of the demand for fish in the country (800,000 tonnes per year against a demand of 1 million tonnes).

An important social impact on the economy is the job opportunity afforded to a large number of the population who would have been jobless, considering the unemployment situation in the country. A large number of people are involved in the marketing system.

The viability and profitability of the frozen fish industry has attracted a lot of potential investors, who have contributed immensely to the investment ventures in the economy.

## Outlook

From the foregoing, it is clear that in order to meet the projected demand of 1.5 million tonnes per annum in 1980, the frozen fish industry will have to expand immensely. The policy of the third National Plan is mainly to boost the indigenous industry and encourage industrial fishing.

Some of the policies for more efficient utilization include: improved transportation, fish storage, processing and marketing schemes; the proposed establishment of fishing terminals; and the plan to link up the coastal areas with the hinterland through better feeder roads and improved waterways. On marketing, the government will assist the establishment of facilities for fish storage, processing and distribution at strategic points: these facilities include cold storage, refrigerated trucks, and fish markets.

## References

**Federal Department of Fisheries.** *Report on fishery survey of Nigeria* (1975).

**Krone, W.** (1970). Frozen fish marketing in West African countries. *FAO Fish. Rep.* No. 96. Rome: FAO. 60pp.

# Marketing of frozen fish in India

**K. K. P. Menon**
Tata Oil Mills Co Ltd, India

## Summary

The utilization of fish in India is based largely upon traditional methods. Commercial freezing and canning were introduced in the early 1960s mainly for processing shrimp for export. In more recent years the patterns of utilization are changing and frozen fish products are finding domestic markets. Only 5 per cent of the catch is frozen but the consumer resistance to frozen fish is disappearing and, as socio-economic conditions improve, the market for frozen fish is expected to increase.

The full potential for frozen (and fresh) fish can be realized only through a comprehensive 'cold chain' distribution system. The problems associated with connecting the landing centres to the retail marketing centres are discussed. The Government of India's Integrated Fisheries Project has shown that a substantial trade in frozen fish can be established provided an efficient system of handling, storage and distribution can be operated. Details of the current frozen distribution system are outlined in the paper.

## Résumé

La consommation de poisson en Inde repose en grande partie sur les méthodes traditionnelles. La congélation et la mise en conserve dans un but commercial ont commencé à être utilisées au début années 1960 essentiellement pour la préparation des crevettes pour l'exportation. Au cours des dernières années, les modes d'utilisation ont changé et les produits de pêche congelés trouvent maintenant un marché intérieur. Cinq pour cent seulement du produit de la pêche est congelé, mais la réticence des consommateurs à l'égard du poisson congelé tend à disparaitre et comme les conditions socio-économiques s'améliorent, on s'attend à ce que la commercialisation du poisson congelé s'accroisse.

La réalisation complète des possibilités concernant le poisson congelé (et le poisson frais) ne peut être réalisée que par l'intermédiaire d'un système de distribution de "chaine de froid'. Les problèmes associés aux liaisons entre les ports de pêche et les centre de commerce de détail sont discutés. Le Projet Intégré concernant la pêche du Gouvernement de l'Inde met en évidence le fait qu'un commerce important de poisson congelé peut se développer à condition que puisse être réalisé un système efficace de manipulation de stockage et de distribution Des détails concernant le système courant de distribution de produits congelés sont esquissés dans cet article.

## Resumen

La utilización de pescado en la India se basa principalmente en métodos tradicionales. La congelación y el enlatado comercial se introdujeron a principios de los años 60 principalmente para la preparación de camarones para exportación. En los últimos años los modelos de utilización están cambiando y los productos congelados encuentran el mercado interior. Sólo el 5 por ciento de la pesca se congela, pero la resistencia del consumidor al pescado congelado está desapareciendo y, a medida que mejoren las condiciones socio-económicas, se espera que aumente el mercado de pescado congelado.

El potencial total del pescado congelado (y fresco) sólo se puede conseguir a través de un sistema de distribución basado en una completa 'cadena de frío'. Se discuten los problemas asociados a la conexión entre los centros de descarga y los establecimientos de venta al por menor. La Administración del Proyecto de Pesquerías Incorporadas de la India ha demostrado que se puede establecer un comercio importante de pescado congelado si se pone en funcionamiento un sistema eficaz de manipulación, almacenamiento y distribución. En el artículo se describen brevemente los detalles del actual sistema de distribución de productos congelados.

The average annual landing of fish in India is about 2 million tonnes, but the fishery industry as such depends mainly on shrimp. The Indian seafood industry which earned RS 1049 million* in 1975, is identified as a shrimp-orientated industry: 74% of the fish exported is shrimp, which form only about 6.8% of the total landings in the country.

More than 200 species of fish contribute to India's total catch. Among the most important species are oil sardine, mackerel and Bombay duck, which together constitute nearly 38% of the marine fish landings (Eapen and Menon, 1974).

The following are the commercially important fishes used mainly for human consumption in India:

Oil sardine – *Sardinella longiceps*
Mackerel – *Rastreilliger kanagurta*
Pomfrets – *Pampus argenteus, Parastromateus niger* and *P. chinensis*
Elasmobranchs – Sharks, skates and rays
Bombay duck – *Harpodon nehereus*
Jewfish – Sciaenids and croakers
Whitebait – *Anchoviella commersoni* and *A. indica*
Seer – *Scomberomorus commersoni* and *S. guttatus*
Soles – *Cynoglossus semifasciatus* and *Psettodes erumi*
Tunnies – *Katsuwonus pelamis, Euthynnus affinis, Thunnus albacares, macropterus, T. obesus mebachi, Sarda orientalis and Auxis thazard*
Threadfins – *Polydactylus indicus* and *Eleutheronema tetradactylus*
Eels – *Anguilla* spp. and *Muraenesox* spp.
Whitefish – *Lactarius lactarius*
Perches – *Lates calcarifer, Epinephelus* sp., *Lutianus* sp., *Nemipterus japonicus* etc.
Catfish – *Arius* spp.

There are appreciable stocks of unexploited pelagic fish off the south-west coast of India. Mechanization of fishing vessels was initiated in India in the 1950s and at present there are about 12,000 small mechanized vessels besides a good number of large trawlers actively engaged in fishing both on the west and east coasts. The phenomenal progress India is making in the fields of mechanization and deep-sea fishing will in the near future result in the proper exploitation of this and other potential resources of the shelf region, thereby greatly increasing the fish landings from the present harvest of 1.2 million tonnes and augmenting the supply of protein-rich fish to the Indian consumer.

## Development of frozen fish marketing

Until recently fish in India has been used fresh, sun dried or pickled, and as crude fish meal and fish manure. It was only in the early 1960's that modern methods of freezing and canning came to India on a commercial footing, but this was based on shrimp. Very little was done on processing fish, as seen in Table 1.

During the last few years, there has been some change in the utilization of fish. It can be seen from Table 1 that while more than 60% of the total fish production is fresh, only about 5% is frozen; the growth of fish freezing has however steadily increased year by year. Frozen fish products are now finding a domestic market largely due to improvement in socio-economic conditions, but also because the consumer resistance to frozen fish is vanishing. Until recently even iced fish was not acceptable to many.

The large investment required for the transportation and storage of frozen fish was another hindrance to the development of marketing of frozen fish in India. Modern equipment for processing fish fillets, sliced and in various acceptable forms, was not available in the country until recently. The freezing plants were mostly equipped with plate freezers to process shrimp; only a very few plants have tunnel freezers to process whole fish. This has also contributed to the slow growth of marketing of frozen fish.

The need for a cold chain in the marketing system of frozen fish has been attracting the attention of the authorities as well as the industrialists for quite some time. It is well known that the full economic potential of increased landings can be realized only through adequate arrangements for widespread dispersal of the fish. This can be achieved only through a cold chain system connecting the landing centres to the retail marketing centres. In a tropical country like India where the temperature rises to 40°C, long-distance transport of fish poses serious quality problems. Handling of surplus fish in the glut season is yet another

TABLE 1. *Utilization of fish in India (percentage of total production)*

| *Year* | *Fresh* | *Frozen* | *Cured* | *Canned* | *Reduction* | *Misc.* | *Offal reduction* |
|---|---|---|---|---|---|---|---|
| 1963 | 67.4 | 0.4 | 27.1 | 0.1 | 5.0 | . . | . . |
| 1964 | 70.0 | 1.2 | 21.7 | 0.2 | 5.9 | 0.9 | 0.1 |
| 1965 | 68.8 | 1.3 | 25.6 | 0.4 | 4.1 | 0.2 | 0.1 |
| 1966 | 70.4 | 1.9 | 21.9 | 0.6 | 3.9 | 0.8 | 0.5 |
| 1967 | 66.8 | 3.4 | 19.7 | 0.8 | 5.5 | 1.8 | . . |
| 1968 | 69.1 | 4.1 | 19.3 | 0.7 | 5.2 | 1.6 | . . |
| 1969 | 67.9 | 3.5 | 21.5 | 0.6 | 4.4 | 2.1 | . . |
| 1970 | 67.0 | 4.6 | 20.3 | 0.7 | 5.5 | 1.9 | . . |
| 1971 | 66.0 | 5.3 | 19.3 | 0.7 | 5.6 | 2.9 | 0.2 |
| 1972 | 68.2 | 5.0 | 17.5 | 0.7 | 4.9 | 3.2 | 0.5 |

Source: Menon, 1976

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* 1 Indian Rupee (Rs) = £0.06 at June 1976

problem. If fish are frozen in the fishing season and distributed over a wide area throughout the year in adequately refrigerated carriers, these problems would be resolved.

At the end of 1975, 273 cold stores with a total capacity of 21,558 tonnes and 217 freezing plants with a freezing capacity of 1000 tonnes per day were available in the country. These cold stores and freezing plants could form part of the cold chain system, since their capacities are not fully utilized at present. The following is a summary of guidelines for the establishment of a cold chain system.

New freezing plants or cold stores need to be established in important marine and inland fish landing centres in the country. Cold stores of super class A (below-20°C) with storage capacity of 5,000 to 10,000 tonnes should be set up in urban areas with a population of 0.5 million and above. Smaller cities and towns should have warehouses or cold stores of 500 to 1000 tonnes capacity depending on the consumer demand for the products. Each city in turn should have one or more distribution centres with facilities to keep frozen fish to meet the daily or weekly requirements; these could be equipped with small storage plants or refrigerated lockers. It is necessary to have distribution centres in cities for supplying fish to retailers (eg departmental stores, supermarkets, fish stalls etc) who in turn sell the fish to consumers (Sreenivasan and Hiremath, 1974).

Efforts have been made by the Government of India's Integrated Fisheries Project (erstwhile Indo-Norwegian Project) in the freezing and marketing of fish and it has been proved that consumer acceptance of frozen fish can be developed in the country. When the Project started experiments on the sale of fish a few years back, the public showed more interest in iced fresh fish than in frozen fish. The various experiments by the Project gave the following results (Anon., 1970):

1. In marketing frozen fish and fish products, the primary requirement is for proper storage at the distribution centre.
2. Fish in convenient and dressed forms, such as fish slices, fish portions and fish fillets in packets of 0.5 and 1 kg, have better 'mobility' than round fish or larger sized packs since they meet the requirements of families which do not have storage facilities at home.
3. For quick 'mobility' of fish and fish products a choice of three or four varieties should be available to the customers.
4. Fish and fish products packed in cartons and polythene bags were more acceptable.
5. Above all, an assured supply of fish and fish products attracted steadily increasing sales.

These results prompted the Integrated Fisheries Project to plan the establishment of a chain store system in South India. Time has proved that it was worth putting up such chain stores. The general public can now buy fish and fish products at fixed prices without the need to bargain with the fishmongers at the markets.

## References

**Anon.** (1970) Agenda notes for the 8th meeting of the Central Board of Fisheries, India.

**Eapen, P. K. and Menon, K. K. P.** (1974) *Proc. Symp. Fish Process. Ind. India.* (In Press)

**Menon, M. D.** (1976). *Souvenir,* 2nd India Seafood Trade Fair. p.61

**Sreenivasan, N. and Hiremath, G. G.** (1974) *Seafood Export J.* **VI** (1) 51.

# Discussion

There were two discussion periods for this session; after the presentation papers and after the moderator's review.

## Papers 1 and 2

The discussion was fairly wide ranging but the more important topics were the prospects for, and the problems associated with, the local consumption and export of frozen fish and the use of frozen storage to even out the fish supply when fishing activity is seasonal.

Commenting on the paper by **Vidot** and **Ratcliffe**, **Sabri** felt that prospects for exporting fish from developing countries, particularly the small ones, are generally poor; local demand must be satisfied first, investment potential is limited and, although the prospects for export of frozen prawns are better, the local price for fresh prawns is still very high. In reply, **Vidot** intimated that prospects in the Seychelles are fairly good since the trade is based on handlined fish of prime quality, which would, hopefully, compete on the world market; also the local demand is already satisified except for temporary seasonal shortages.

The problem of obtaining refrigerated sea transport to carry frozen fish was mentioned by **Hjul**. To this, **Vidot** commented that quantities for export must be sufficient to interest commercial shipping, especially if the harbour in question is not a regular port of call. The possibility of using insulated trunks which may, in many countries, be better than refrigerated vehicles was suggested by **Krone**, who also mentioned that investigations into the use of containers are in hand and air transport is also being considered.

Several delegates contributed to a discussion on ciguatera poisoning initiated by **Watkins** who was concerned that frozen tropical fish reaching the London market may be toxic. **Vidot** said there have not been any outbreaks in the Seychelles, although the problem has occurred only 400 miles away. **Liston** then outlined some of the problems related to ciguatera intoxication. It is an ill-defined toxin associated with the food chain of certain fish. A particular species may be toxic in one area, but elsewhere the same species may be completely safe. There is no satisfactory method of identifying toxic fish, although local fishermen experienced in handling susceptible species claim that they can tell if the fish are poisonous. **Liston** felt that this is an important problem area in which additional work is needed. **Steinberg** added that it may be possible to establish some pattern from relating present data on toxic species to size of fish, season, etc and **Moal** commented that ciguatera occurs unpredictably and it is almost impossible to offer a guarantee of safety.

In response to **Disney's** query on the importers' reaction to the improved quality of frozen fish from the Seychelles, **Vidot** replied that both the importers and processors resent the higher costs incurred in improving quality.

The topic for discussion changed following **Mattos'** request for opinions on the use of superchilling for road transport. He defined the temperature they have used for superchilling as –1.9°C, when the fish is 80% frozen. It was generally agreed that superchilling should be avoided; **Steinberg** commented, and **Lima dos Santos** agreed, that this method resulted in loss of quality, mainly textural. **Moal** pointed out that since superchilling demands extremely accurate temperature control it is not possible in practical terms and **Waterman** stressed that, in comparison with icing, superchilling is too expensive and too difficult to control; the method has been abandoned in Europe.

**Levy** commented that one important aspect of freezing had, he felt, been overlooked, namely that fish are not available throughout the year, but during the peak season the surplus can be frozen. He outlined an interesting development in Barbados where, some 10 years ago, facilities including a tunnel freezer and a cold store were built to combine fish and meat freezing and storage. By pooling these facilities it was possible to provide a steady supply of both fish and meat throughout the year. However at that time, the freezer was not being used to full capacity and a private company later approached the Government with a proposal to freeze shrimp during a second daily shift.

## Papers reviewed by the moderator

In this discussion there were a few questions arising from the **Talabi** and **Makanjuola** paper but most of the period centred upon the socio-economic impact on consumers and on the artisanal fishery of introducing frozen fish to developing countries. There was also some discussion on the question of deep-sea trawlers fishing in 'foreign' tropical waters. Most of the experiences cited, referred to situations in West Africa where the frozen fish trade has made considerable progress. Although there were only three papers reviewed there was a lot of interest from the floor.

**Steinberg** opened with a comment on the paper by **Walton** that consumers in highly industrialized countries are conservative by nature; eating habits are not easily changed.

Commenting on the **Talabi** and **Makanjoula** paper, **Waterman** welcomed the inclusion of such useful (and detailed) information and data in the tables, but felt that additional footnotes could, perhaps, have been given for some of the tables, eg date of information, source, etc. **Hjul** then referred to a footnote to Table 1 that 'distant-water fishing fleets are operated on a charter basis', and asked **Talabi** where the vessels were from, their size and ownership; he added that the UK has a number of surplus trawlers at present. **Talabi** replied that he was not aware of the current charter details and suggested that **Krone** might wish to comment. **Krone** then mentioned that vessels from Poland, USSR, Japan, Spain, Bulgaria, Rumania and Germany are fishing off West Africa. A number of delegates felt that countries, such as Nigeria, should endeavour to catch their own deep-sea fish, but to do this would, as **Sagua** pointed out, require a large input of cash and extensive training programmes. From **Enin**, the meeting heard that Ghana is no longer encouraging the use of charter vessels. There is, however, a joint tuna fishing and canning venture between Mankoadze Fisheries, of Tema, and an American company; some of the canned tuna is for local consumption but most is for export. The rest of the deep-sea fishing vessels are owned either by the state or by private Ghanaian companies. **Krone** suggested that developing countries should use existing boats, rather than building new ones, to establish their own deep-sea fishery since there is a lot of spare fishing (and storage) capacity in the world. They must also decide whether a land-based or sea freezing system is preferable.

**Okonkwo** mentioned that two companies have been formed in Nigeria and orders have been placed for the construction of shrimp trawlers, purse seiners and mother ships. In response to **Hjul's** query, **Okonkwo** added that the boats are being built outside Nigeria.

The resistance to frozen fish by consumers in developing countries was then discussed. **Sagua** pointed out that when frozen fish was introduced into Nigeria it was very unpopular but extremely cheap; in fact it was sold at a loss. It became more popular after the consumers had been taught how to defrost and prepare the fish for cooking. Distribution of frozen fish is extending throughout the country but the preference for fresh fish and the initial bias against frozen fish do, however, still exist. **Sagua** felt that the current, relatively cheap price of frozen fish may be needed as an incentive to the buyer. Following **Steinberg's** comment, from **Bonsu's** paper in Session 3, that consumers in Ghana are suspicious of frozen fish, **Enin** agreed, but pointed out that this was mostly due to the poor quality of the fish. Since April 1976, frozen fish passes directly from the state-owned depots to cold store operators, retailers and smokers; the middlemen are bypassed. The quality is now improving and, due to the shortage of meat, the demand for fish is rising. She also mentioned that frozen fish is transported over long distances in refrigerated vehicles; for short journeys insulated vans are used and the frozen fish, which are smoked (after thawing) before distribution, are transported in lorries. In reply to **Steinberg's** question on the reliability of the refrigerated transport, **Enin** explained that the vehicles are driven slowly to reduce the incidence of breakdown.

There followed a discussion on the integration of the frozen fishery with the artisanal fishery. **Krone** commented, in response to **Steinberg's** question, that while the deep-sea fisheries have progressed rapidly, there is generally a lack of development of the artisanal fisheries. (This point was in fact endorsed by **Sagua** earlier on in the discussion.) **Krone** also pointed out that there is no direct competition between the two fisheries since they are fishing for different species and the products themselves are different, as are the marketing systems. He felt that the artisanal fishery neither benefited nor suffered from the introduction of a frozen fishery. On the other hand, **Meidell-Gerhardsen** felt that any distant-water development is bound to have a detrimental effect on the small-scale fishery. **Talabi** added that in Nigeria the frozen fishery affects the artisanal fishery in two ways; it underscores the problems of the fishery as a whole by making it appear to be growing, and its sophistication frightens the artisanal fishermen. In response to **Disney's** comment on the channelling of home- and foreign-caught frozen fish through the same coldstore network, **Talabi** mentioned that the shrimp by-catch does go through the same system. **Krone**, however, felt that the new marketing infrastructure is generally not used to advantage.

# Session 5

## Fish meal, fish silage and new products

**Wednesday 7th July**
**Morning**

Chairman
F. A. Peterkin
Guyana Food Processors Ltd
Guyana

Moderator
D. G. James
Department of Fisheries
FAO

Rapporteur
R. A. Moal
Société Centrale pour
l'Equipment du Territoire
International
France

# Fishmeal manufacture in the tropics

**S. M. Barlow**
International Association of Fish Meal Manufacturers, UK

**Summary**

The basic process of fishmeal manufacture is described with special attention to problems which might arise under tropical conditions. Storage of the fish and fish meal is likely to need special care and, therefore, a detailed account of modern practices is given. The factors, which should be considered before establishing a fishmeal operation, are discussed together with examples of estimated costs of installing a small-scale fishmeal plant.

**Résumé**

Le processus de base de la fabrication de la farine de poisson est décrit et une attention particulière est portée aux problèmes qui pourraient survenir sous les climats tropicaux. Le stockage du poisson et de la farine de poisson nécessite des soins particuliers et un compte rendu détaillé des procédés modernes est présenté. Les facteurs à prendre en considération avant de réaliser une industrie de farine de poisson sont discutés avec des exemples de coûts estimatifs pour l'installation de petits établissements de fabrication de farine de poisson.

**Resumen**

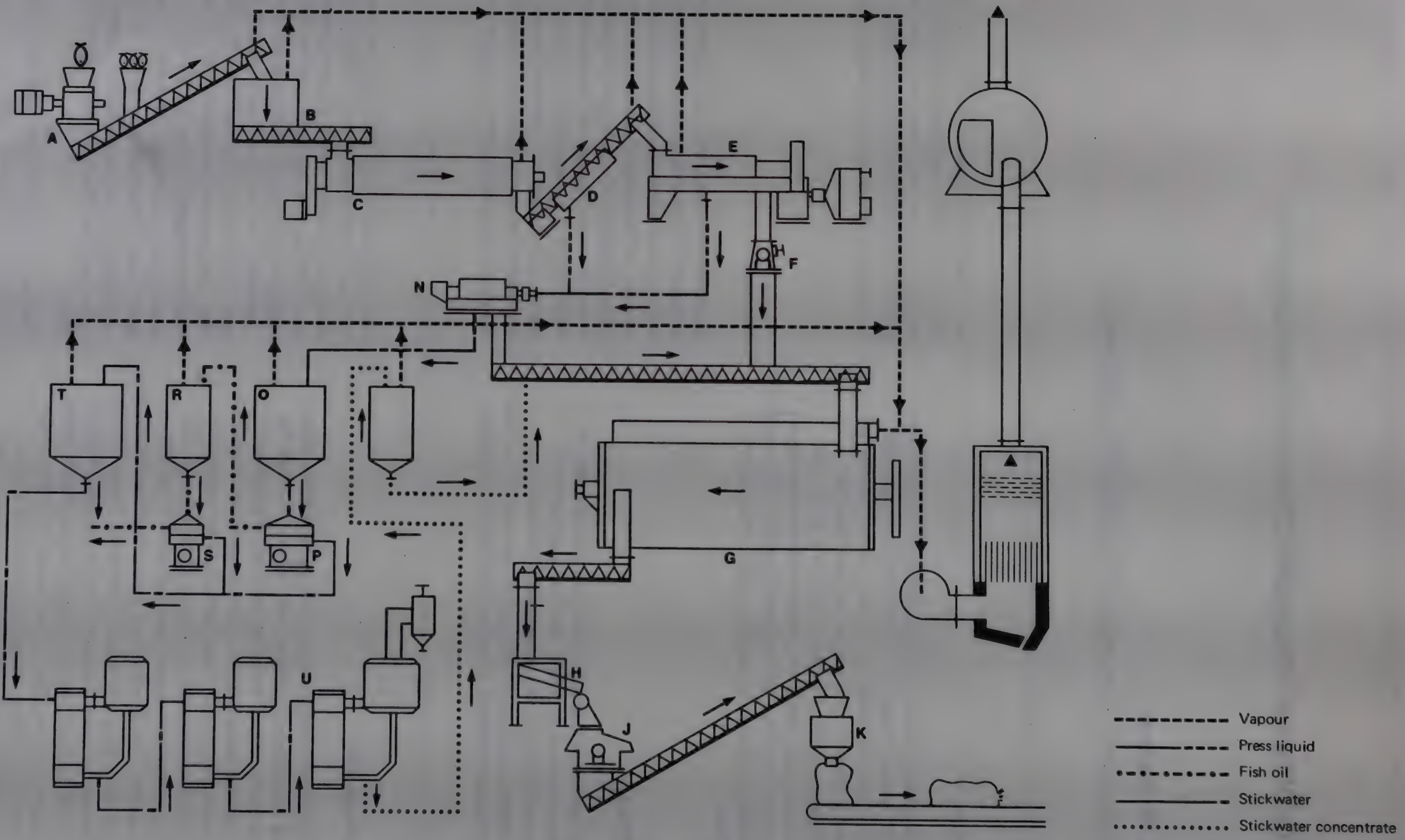
Se describe el proceso básico de la fabricación de harina de pescado, con atención especial a los problemas que surgen en condiciones tropicales. El almacenamiento del pescado y de la harina de pescado exige probablemente cuidados especiales; por ello se da información detallada de las prácticas modernas. Se estudian los factores que deben tenerse en cuenta antes de la puesta en funcionamiento de una fábrica de harina de pescado, juntamente con ejemplos de los costes estimados de instalación de una planta de harina de pescado a pequeña escala.

## Introduction

I will start my paper by introducing myself and stating my credentials for dealing with this subject. I am the Scientific Adviser to the International Association of Fish Meal Manufacturers. The International Association provides a centre for co-operation on the commercial and scientific aspects of fishmeal production and use between member countries and associated research institutes. The International Association has 18 member countries, these are: Belgium, Bermuda, Canada, Chile, Denmark, France, Germany, Iceland, Ireland, Morocco, the Netherlands, Norway, Peru, Portugal, South Africa, Sweden, UK and USA. It can be seen that none of the member countries, except for Angola, has any real experience of manufacturing fishmeal under tropical conditions. However, the manufacture of fish meal throughout the world follows the same broad principles and I have drawn upon the experience of members of the International Association in presenting these principles to you with particular emphasis, where necessary, on any matter which should be considered when planning a fishmeal operation in tropical conditions. The length of this paper allows me to deal only with the main principles of setting up a fishmeal operation under tropical conditions but I would recommend anybody here, who is seriously considering setting up such an operation, to read FAO Fisheries Technical Paper No 142, entitled 'The production of fish meal and oil', prepared by the Fishery Industries Division of FAO (1975). This paper is most comprehensive and deals with the subject in much greater detail than I am able to do in my paper. I would also draw your attention to a paper by Kreuzer (1966) entitled 'Planning and Installation of a Fish Meal Plant'.

Fish meal is a carefully produced component of animal feedstuffs which is mixed with vegetable proteins usually by feed mixing companies and farmers. It is used mainly for feeding poultry, especially broilers and layers, and for pigs, in particular young and growing pigs. It is also used in fish farming, mink feeding and other livestock rearing.

Figure 1
Layout of a fish meal plant


A
B
C
D
E
F
N
G
H
J
K
O
P
R
S
T
U
Vapour
Press liquid
Fish oil
Stickwater
Stickwater concentrate

The top ten producers of fish meal in 1974 were Japan, Peru, USSR, USA, Norway, Denmark, South and South West Africa, Chile, Iceland and the UK. The top ten consumer countries in the same year were Japan, USSR, USA, Germany, UK, Poland, South and South West Africa, Peru, Denmark and Spain.

### Manufacture

Figure 1 shows the layout of a typical fishmeal plant. Large fish are hashed and coarsely chopped (A), while smaller fish are fed directly to a feeding hopper (B) from where they are taken to a steam cooker (C). After cooking, the coagulated material is pre-strained in a strainer conveyor (D) or a vibrating screen before entering the press (E). The products from the press, namely press cake and press liquor, are treated as follows.

The cake is disintegrated in a tearing machine (F) to facilitate mixing with a stickwater concentrate (which will be defined later) and drying in a dryer (G). The meal passes over a vibrating sieve screen (H), generally furnished with a magnet, to remove extraneous matter such as pieces of wood and metal etc before entering the hammer mill (J). The ground meal is sieved and weighed out in bags by the scale (K), the bags are closed (eg by stitching) and conveyed to a store. Alternatively, the meal is stored in a holding silo before bagging, pelleting or storage in bulk.

The liquor passes through a decanter (N) to remove most of the sludge. The press liquor then passes through a buffer tank (O) before separation into oil, stickwater and fine sludge in the centrifuge (P). The sludge is added to the press cake. The oil passes through a buffer tank (R) before water and sludge impurities are removed (polishing) in the oil separators (S). After polishing, the oil passes to the storage tanks. The stickwater is collected in buffer tank (T) and concentrated in multiple effect evaporators (U). The concentrated stickwater, called solubles, is mixed thoroughly with the decanter sludge and press cake before drying in the dryer. In some cases, the solubles are sold separately.

Figure 2 gives an example of the material balance in a fishmeal operation. It can be seen that 1000 kg of raw fish are reduced to about 212 kg of meal (ie a reduction to approximately one-fifth). In this particular example, 108 kg of oil were produced but this would be dependent upon the amount of oil in the fish before processing, which varies according to the species and time of year.

There is another basic process still in existence in some unsophisticated areas for producing fish meal and that is simply to sun dry the fish after they are caught. This method is outdated and unacceptable in international trade. The product would be rejected in many countries. Although this has the outstanding advantage of being very cheap in as much as little or no capital outlay is required for reduction equipment and no fuel oil costs are incurred, unfortunately there are many disadvantages. The product will not be uniform and will contain widely varying quantities of protein, oil and moisture depending on the season during which the fish were caught and the degree of drying. This is a major disadvantage to a broiler producer who attempts to formulate diets to a constant composition and would expect consistency in the feed materials he is mixing. Material which is sun dried in the tropics is also liable to heavy insect and bacterial infection. Bacterial infection of the livestock consuming the final product can, in turn, infect the consumer eating the livestock. In fact, the infection could be deadly. The conditions of sun drying encourage bacterial contamination of the fish from rodents, birds, dogs etc and the temperature and moisture levels of the fish during drying are optimum for considerable bacterial growth. Sun drying on sandy beaches is occasionally practised and this can lead to the presence of undesirably high levels of sand in the sun dried fish meal. Finally, the simple process means that there is no way of recovering the valuable fish oil which could be sold to refiners and hardeners for inclusion in margarines etc. Sun drying of fish material for the production of fish meal is not regarded by my colleagues or myself as an approved process.

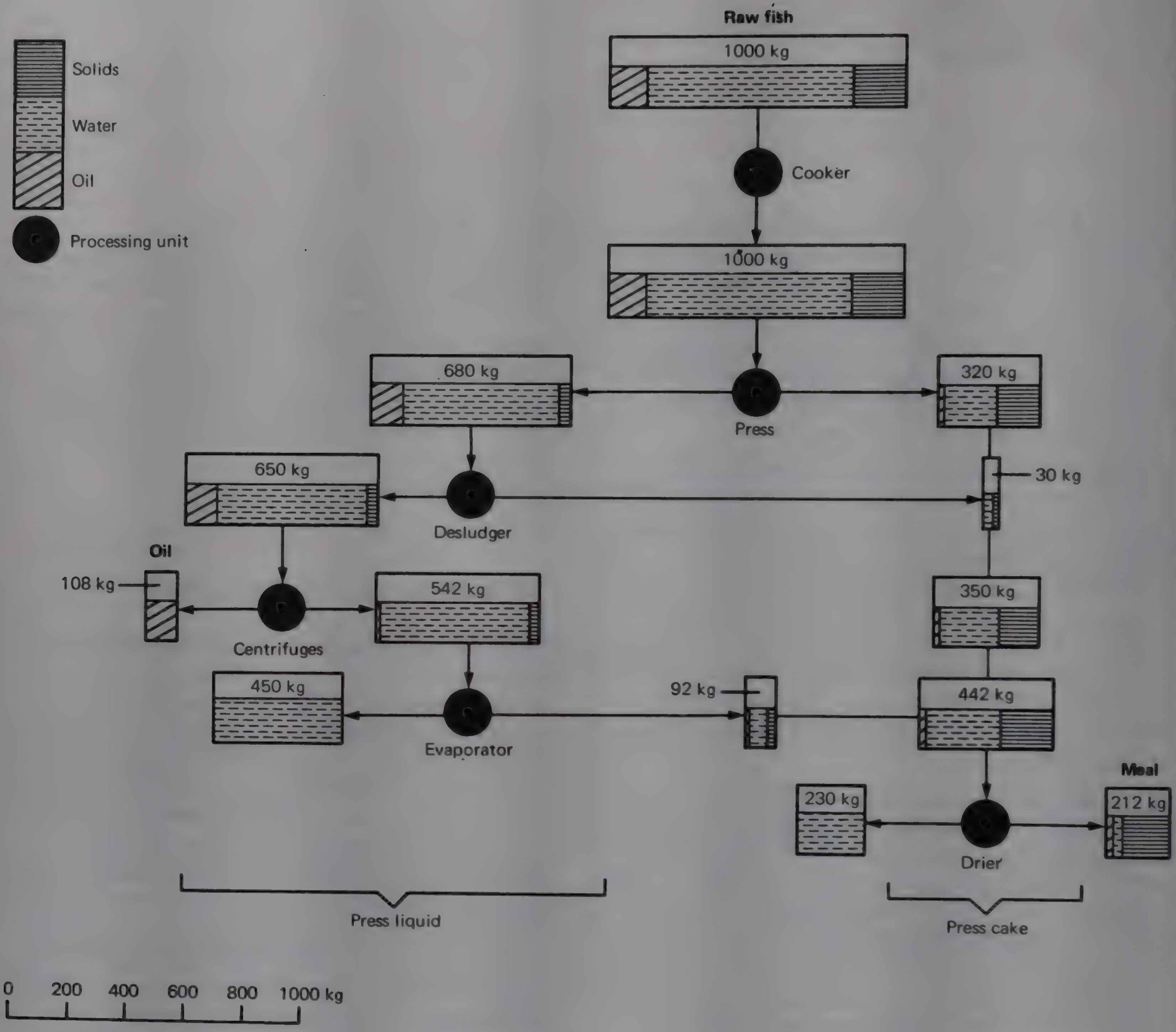
### Availability and suitability of raw material

It cannot be emphasized too strongly that, before emarking upon the establishment of a fishmeal industry, it is necessary to have a realistic estimate of the amount of raw material which will be available to the factory and the seasonality of this raw material. This will have an important effect on the economics of a fishmeal operation and the type and capacity of plant required. Too many fingers have been burned by over-optimistic assessment of the fishery's potential of certain resources. It is also necessary to study the price of the raw material and its fluctuation throughout the year. Additional factors, such as the situation and distance of landing places from the site of the plant under construction, the possibility of centralizing landings etc, are also important.

In considering the establishment of a fishmeal industry, a biological survey of the potential fish resources should be carried out and used as a primary basis for the study of the feasibility of the project. These data enable the determination of the time of the operation and optimum capacity of the plant. If sufficient data are available, the number of plants and their most suitable location within an area could be estimated.

It is important to have information on the suitability of the raw material for fishmeal manufacture. A number of tropical species of fish are known to contain toxins which could be detrimental to livestock which are feeding on fish meal produced from these fish. If such exotic fish species are likely to be included in the catch, it is important to carry out preliminary feeding trials to establish the suitability of the fish meal for livestock production. It is also important to have information on the fat content of the raw material to be used for reduction since this is an important factor in determining the type of equipment necessary and the economics of the operation. Depending on the oil content, fish can be grouped into two categories; namely, oily fish with a fat content of more than 2.5%, and non-oily fish (lean fish or white fish) with a fat content of less than 2.5%.

**Figure 2**
**Material balance in fish meal production**



## Processing of fish meal in the tropics

As explained earlier, the processing of fish meal does not differ in principle from one type of fishery to another. However, there are certain problems which are likely to be encountered in a fishmeal operation in the tropics and these should be considered.

Since the temperatures in these areas are very high, it is certain that the fish will deteriorate quickly, such that there would be a breakdown in their physical form. The breakdown of the fish is caused by two main factors; bacterial activity on the fish and autolysis caused by the enzymes within the fish. This breakdown leads to a loss of protein and oil from the fish, in the form of run-off liquors, and can also lead to the production of obnoxious odours which could be unacceptable to people in the vicinity of the fishmeal operation. In certain circumstances, some of the gases, such as hydrogen sulphide, can be toxic and can lead to mortality in enclosed areas. There has been a suggestion that the fresher the fish, the better the fishmeal quality although experimental results do not provide proof on this point.

Petersen (1971) measured the weight reduction of herrings stored for a period of about 15 days at temperatures ranging from 0°–12°C (Figure 3). It can be seen that at 12°C there appeared to be a reduction of 12.1g per day in the weight of 1000g of herring. At higher temperatures which are encountered in the tropics, this loss in weight would be even greater. This loss in weight is reflected in a loss in oil as seen in Figure 4 and a loss in protein as illustrated in Figure 5.

During these conditions, the free fatty acid content in the fish oil also increases; this makes the marketing of this oil less attractive since the oil refiners and hardeners insert penalty clauses in their contracts, which apply at levels higher than the prescribed maximum. In order to prevent deterioration of the fish and the subsequent losses, fish preservation should be practised.

Chemical preservatives for raw fish act immediately on the bacteria on the surfaces of the fish but there is some delay in action on the interior (stomach and intestines) depending on the rate of penetration of the preservative. Sodium nitrite, sodium sulphite and ascorbic acid, ben-

**Figure 3**
**Weight reduction of herring during storage**

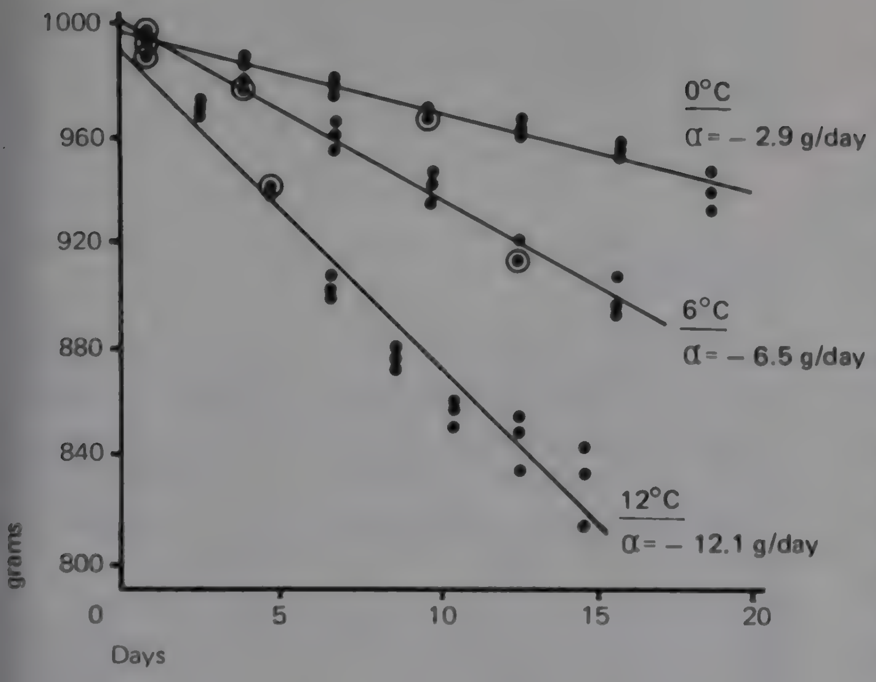


**Figure 4**
**Oil loss from herring during storage**

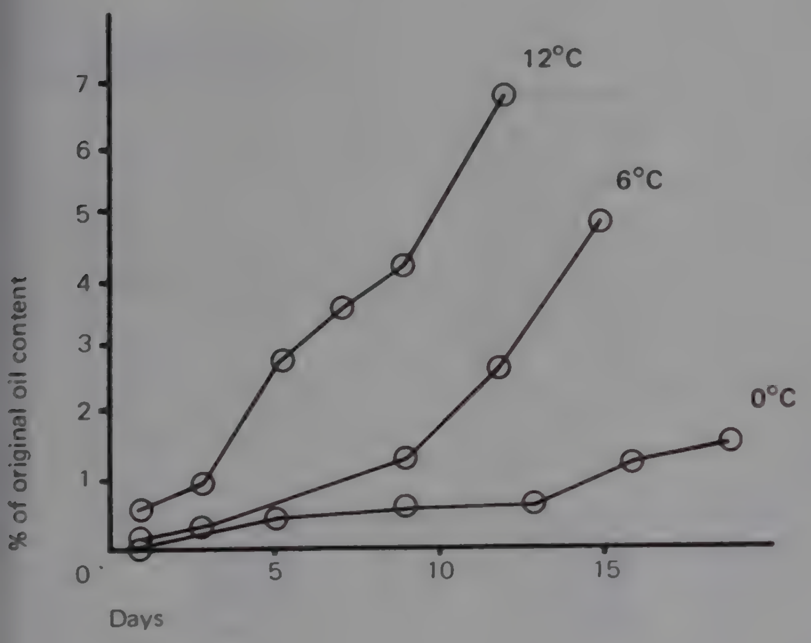
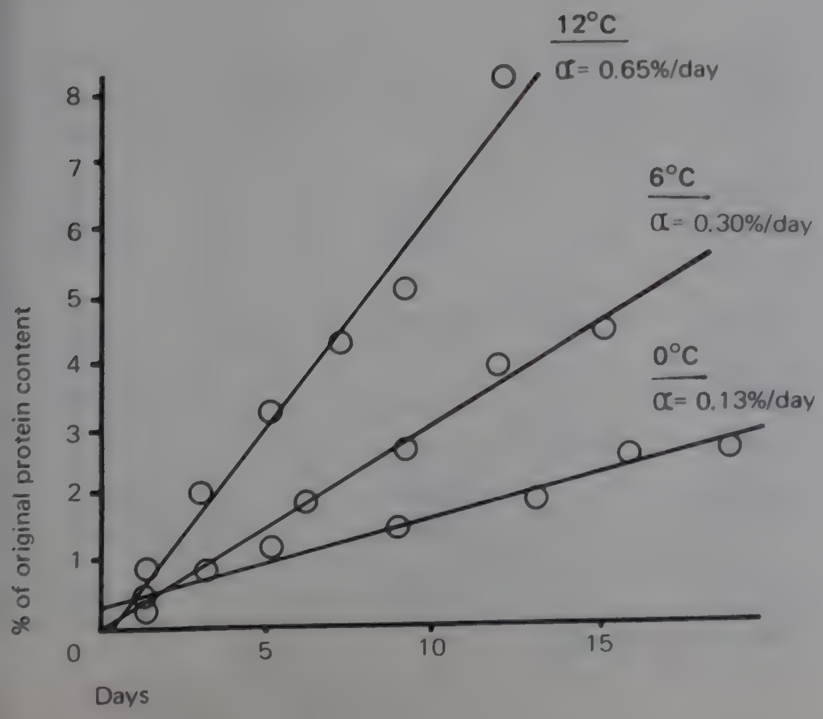


**Figure 5**
**Loss of protein in blood water from herring during storage**



zoic acid and many more preservatives have been evaluated but they are only used to a very limited extent. Sodium nitrite has demonstrated comparatively favourable properties for preserving species such as herring. However, special measures must be taken when meal is manufactured from fish which have been preserved by nitrite; this is because it may react with other components of the raw material and form toxic compounds which are harmful to the animal ingesting the meal. The use of nitrite must, therefore, only be permitted under the most careful supervision and should not be encouraged, particularly when developing a fishmeal operation.

Formaldehyde is widely used and under certain circumstances also exerts a beneficial effect on the raw material. The use of small amounts (eg 0.05% formalin based on the weight of the fish) has no detectable deleterious effect on the protein quality but higher levels could reduce the protein quality of the fish meal. There is evidence that continuous use of formaldehyde can encourage corrosion of the fishmeal plant.

In tropical and temperate areas, where the fish may be caught at high temperatures and far away from the plant, chilling appears to be the most promising effective method of preserving bulk stored fish. Chilling has the advantage of reducing the activity of enzymes and bacteria. Table 1 shows the effects of various preservatives on the weight losses measured on summer herring in Denmark. It can be seen that refrigerated sea water was greatly superior to the chemical methods of preservation. In principle, two methods of chilling may be considered; namely, refrigerated or chilled water systems and mixing of ice with the fish. These methods are, however, only now emerging from the experimental stage for the preservation of fish which are for reduction. However, preliminary indications suggest that, in many cases, the cost of chilling can be recovered by the reduced losses of protein and oil.

TABLE 1. *Weight losses measured on summer herring and effect of preservatives*

| *Preservative* | *Concentration* | *% weight loss* |
|---|---|---|
| CTC | 2 ppm | 15.9 |
| Formaldehyde | 0.05% | 15.6 |
| Formaldehyde and nitrite | 0.05% | 9.1 |
| Refrigerated sea water | | 1.6 |
| Control | | 19.0 |

Source: Petersen, 1971

## Storage and packaging of fish meal

Under tropical conditions of high temperatures and humidity, the storage and packaging of fish meal presents some problems. Fish meal from oily fish presents a storage problem since the oil oxidizes actively; this leads to a considerable rise in temperature so that a fire risk is even involved in its storage. The measures taken to prevent spontaneous heating of stored fish meal may differ according to the species of fish used for reduction. It is common practice these days to add between

400 and 700 ppm ethoxyquin as a chemical anti-oxidant which stabilizes the meal; this is normally added immediately after the meal leaves the dryer.

Before the use of anti-oxidants it was common to stack the sacks of meal singly for a few weeks so that the surfaces of the sacks were exposed; this allowed dissipation of the heat generated by the oxidation of the oil rather than allowing it to build up in a confined space and lead to spontaneous combustion. Polyethylene laminated multi-layer paper sacks are almost air-tight and, therefore, hamper the diffusion of oxygen into the meal through the sack. This wrapping has generally proved to be sufficient protection against spontaneous heating of the meal but this might not always be the case. Under extreme conditions, it is probably wise to treat with anti-oxidants and pack in polyethylene laminated multi-layer paper sacks.

Whole meal is more hygroscopic than normal meal and must be protected against absorption of moisture from the atmosphere especially in humid tropical regions. In this respect the polyethylene laminated multi-layer paper sacks have also proved fully satisfactory. If the moisture level of the meal is allowed to rise above 15%, these conditions allow the growth of undesirable moulds and bacteria and, also, compacting of the meal occurs under pressure eg at the bottom of the stacks of meal.

The fish meal must also be protected from insect infestation as there are many, and vigorous, varieties in tropical regions.

## Cost estimates

Table 2 is an estimated calculation of cost and profit for Atlas-Stord* fishmeal plants based on the average prices, wages and costs in Western Europe during the past six months. It should be noted that the 15 and 25 tonne capacity plants are package plants without means of recovering the stickwater, whereas the 60 tonne capacity plant has a stickwater evaporator included. Consequently, the 60 tonne plant has a higher yield of fish meal per day than the other two. These calculations are included simply to illustrate the factors which have

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*The use of commercial names does not imply a recommendation.

TABLE 2. *Calculation of cost and profit for Atlas-Stord fish meal plants*†

| | | *Without stickwater concentrating plant* | | | | *With stickwater concentrating plant* | |
|---|---|---|---|---|---|---|---|
| | *Type* | T1W | | T2W | | T5WH | |
| Capacity per day[a](t) : | | 15 | | 25 | | 60 | |
| Capacity per year[b](t): | | 3,000 | | 5,000 | | 12,000 | |
| Output per day[a](t): | fish meal | 2.7 | | 4.5 | | 13.5 | |
| | : fish oil | 0.9 | | 1.5 | | 3.6 | |
| Output per year[b](t): | fish meal | 540 | | 900 | | 2,700 | |
| | : fish oil | 180 | | 300 | | 720 | |
| | | | US $ | | US $ | | US $ |
| Operation costs per day[a] : | fuel oil US $93/t | 550 kg | 51 | 900 kg | 84 | 3.650 kg | 339 |
| | : electricity US $0.05/kW | 840 kW | 42 | 960 kW | 48 | 1.830 kW | 92 |
| | : bags US $0.28 each | 54 bags | 15 | 90 bags | 25 | 270 bags | 76 |
| | : lubricants etc | | 3 | | 5 | | 8 |
| | : operators, persons/shift | 2 pers. | 144 | 2 pers. | 144 | 3 pers. | 216 |
| | : total | | 255 | | 306 | | 731 |
| Operation costs per year[b] : | | | 51,000 | | 61,200 | | 146,200 |
| Overhead costs per year[b] : | 10 years depreciation of total investment (plant, boiler, installation, CIF expenses) of US $ | 200,000 | 20,000 | 235,000 | 23,500 | 455,000 | 45,500 |
| | : interest 10% average | 100,000 | 10,000 | 120,000 | 12,000 | 230,000 | 23,000 |
| | : maintenance 2% | 200,000 | 4,000 | 235,000 | 5,000 | 455,000 | 9,100 |
| | : insurance, share of adm. costs | | 4,000 | | 5,000 | | 9,100 |
| | : total | | 38,000 | | 45,500 | | 86,700 |
| Raw material[c] per year[b] : | fish and fish offal US $45/t | 3,000 t | 135,000 | 5,000 t | 225,000 | 12,000 t | 540,000 |
| Total costs per year[b]: | | | 224,000 | | 331,700 | | 772,900 |
| Income per year[b] : | fish meal US $350/t | 540 t | 189,000 | 900 t | 315,000 | | 945,000 |
| | : fish oil US $360/t | 180 t | 64,800 | | 108,000 | | 259,200 |
| | : total | | 253,800 | | 423,000 | | 1,186,900 |
| Net profit per year[b] : | | | 29,800 | | 91,300 | | 414,000 |

Notes: †1st January 1976. [a]Day: 24 hours. [b]Year: 200 working days of 24 hours.
[c]Raw material: fish and fish offal with 8% oil content.

to be taken into account when calculating the profitability of a fishmeal operation. Your attention is drawn to the fact that the yearly capacity of the plant is calculated on the basis of 200 working days of 24 hours. In a number of situations the plant may not be able to work for this period of time due to the limitation of supply of raw material. In this case, the capital expenditure, depreciation etc will remain the same but the quantity of end-products and, therefore, the income per year might be considerably reduced. The cost of raw material is, in most cases, the deciding factor; the question of whether a fishmeal plant is economically justified or not is, therefore, always very closely connected to the availability of raw material and the cost at which this can be acquired. It should be pointed out that, although the fish and fish offal cost is stated to be 45 US $ per ton in Western Europe, this figure differs considerably from country to country.

The price of fish meal and oil is also not static, as can be seen from Figures 6 and 7, and these variations will have to be taken into account when assessing profitability. It is also necessary to take local taxes into account when making one's calculations.

**Figure 6**
**Hamburg quotations for fish meal in US $ per ton (at current DM/$ exchange rates) 1970–1975**

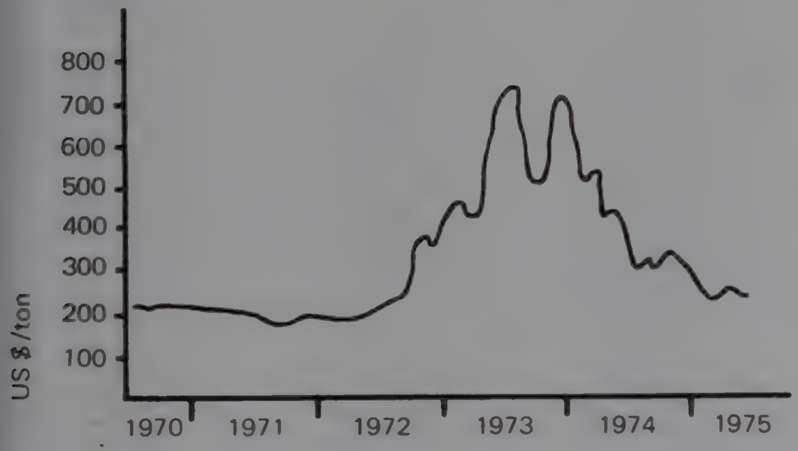
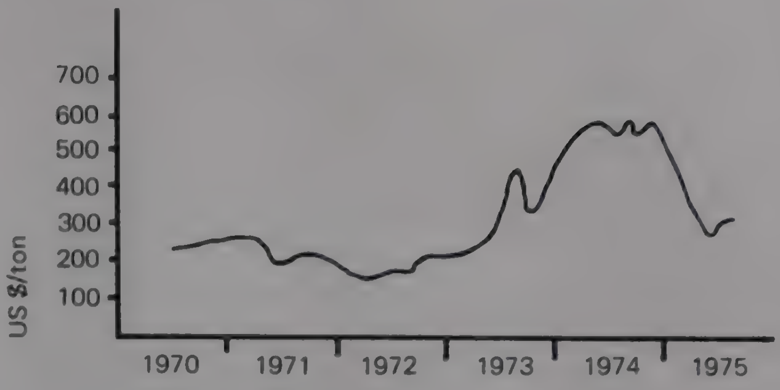


**Figure 7**
**Fish oil prices 1970–1975**



## Conclusion

It has been possible for me to present only a very brief picture of the factors which should be taken into account when considering the establishment of a fishmeal operation in the tropics. However, the Members of the International Association of Fish Meal Manufacturers are willing to give any advice and expertise they have at their disposal to Governments or private individuals who are considering the establishment of a fishmeal operation.

## References

**FAO** (1975) The production of fish meal and oil. *FAO Fish. Tech. Pap.* No. 142. Rome: FAO, 54 pp.

**Kreuzer, R.** (1966) Planning the installation of a fish meal plant, *FAO Paper* FE: TCG/66/32, Rome: FAO.

**Petersen, T. E.** (1971) *News Summary of the International Association of Fish Meal Manufacturers*, **31**, 12.

# Recent developments in fish silage

**J. G. Disney**
Tropical Products Institute, UK
**I. N. Tatterson**
Torry Research Station, UK
and
**June Olley**
Commonwealth Scientific and Industrial Research Organisation, Australia

## Summary

There has been renewed interest in fish silage in several parts of the world as a means of utilizing fish waste. Seasonal or day to day fluctuations and the availability of only small quantities of waste fish, may make the production of fish meal commercially unattractive. In these conditions the production of fish silage may be worthwhile.

A review is made of the present situation with regard to the production of fish silage in Europe. Recent work in the UK, Australia and various tropical developing countries is described and discussed. The possible application of the fish silage processes to utilize otherwise trash fish is discussed with particular reference to small-scale fisheries and conservation of valuable protein supplies.

The proceedings of the symposium on fish silage, organized by the Torry Research Station in Aberdeen in May 1976, are also reviewed.

## Résumé

Il s'est produit un renouveau d'intérêt à l'égard de l'ensilage du poisson en diverses parties du monde en tant que moyen d'utilisation des déchets de poisson. Les fluctuations saisonnières ou journalières et le fait que ne soient utilisables que de petites quantités de poisson de rebut peuvent rendre commercialement sans intérêt la production de farine de poisson. Dans ces conditions, la production de l'ensilage de poisson peut être intéressante.

La situation actuelle concernant la production d'ensilage du poisson en Europe est passée en revue. Les travaux récents au Royaume Uni, en Australie et dans divers pays tropicaux en voie de développement sont décrits et discutés. L'application possible des processus d'ensilage du poisson pour l'utilisation du poisson de rebut est étudié en considérant spécialement les entreprises de pêche de modeste importance et las conservation des substances protéiques.

Les compte rendus d'un symposium sur l'ensilage du poisson organisé par le 'Torry Research Station' à Aberdeen en Mai 1976 sont également passés en revue.

## Resumen

En varias partes del mundo ha habido un interés progresivo por el ensilaje de pescado como medio de utilización de los residuos de pescado. Las fluctuaciones estacionales o diarias, así como la disponibilidad de solamente pequeñas cantidades de residuos de pescado pueden hacer poco atractiva desde un punto de vista comercial la producción de harina de pescado. En estos casos la producción de ensilado de pescado puede ser una solución válida.

Se hace una revisión de la situación actual con respecto a la producción ción de ensilado de pescado en Europa. Se describen y estudian los trabajos recientes realizados en el Reino Unido, Australia y algunos países tropicales en vías de desarrollo. Se analiza la posible aplicación de los procesos de ensilado de pescado para la utilización de los desechos de pescado, con especial atención a las pesquerías en pequeña escala y a la conservación de recursos proteínicos.

Se revisan también las ponencias del simposio sobre ensilado de pescado, organizado por la 'Torry Research Station', en Aberdeen en Mayo de 1976.

## Introduction

An interest in fish silage is related to the desire to make the maximum use of waste fish and fish offal in situations where the quantity involved, or the transport costs, prohibit conversion into fish meal. In small-scale fisheries in the tropics this situation is common. Daily and/or seasonal gluts of fish occur and, because of transport difficulties and inadequate processing facilities, these surplus fish are often under-utilized. The quantities involved do not permit profitable fishmeal manufacture, since even the most modest fishmeal plant requires regular supplies of several tonnes of raw material per day for viable operation. Ironically, countries in this situation are often importing substantial quantities of fish meal to support their expanding animal production industries.

Shrimp trawling operations, principally in SE Asia and Latin America, provide a particular example of fish which are wasted. Substantial quantities of fish are thrown overboard during shrimp trawling either because the trawlers are too small to carry the quantity involved or because the catch is not marketable. Recent reports (Meinke, 1973; IDRC, 1974) suggest that the by-catch can represent considerable losses eg Thailand 400,000 tons per year and India 200,000 tons per year. Recent FAO estimates suggest that world-wide losses may be as much as five million tons per year from this source alone (FAO, personal communication). Serious losses can also occur at fish processing plants, fish landings, markets etc.

In countries where investment capital is available and the waste fish is concentrated in one area, the obvious solution is the reduction to fish meal. Where this is not possible the fish could be utilized by the cattle, pig and poultry industries in the form of silage. The technology of fish silage production is simple, the essential equipment is cheap and the scale of production may be varied at will. These are distinct advantages in the developing country situation.

The original ensilage of forage crops has been extended to deal with problems of losses of protein-rich materials, including fish, and the research has followed two main pathways. In the first, microbiological fermentation is used as a means of acid preservation and, in the other, mineral acid or organic acid (or a combination of the two) is used to lower the pH.

The present paper reviews recent developments in the preparation of fish silage and its suitability as a means of utilizing waste fish. The advantages and disadvantages of the different methods of preparation will be considered in the light of the tropical situation, paying particular attention to small-scale fisheries. In line with the experience of the authors, more attention will be paid to silage prepared by the direct addition of acid rather than to biological silage preparations.

## Fermented products

Recent work, principally in Scandinavia, has been directed towards microbiological fermentation as a means of acid preservation (Petersen, 1953; Jensen, 1973; Roa, 1965; Von Hafstan, 1974; Krishnaswamy *et al.*, 1965). Some work carried out in the tropics will also be reported at this meeting (Stanton and Yeoh, 1976; James *et al.*, 1976).

### *Preparation*

In biological silage preparations, bacteria ferment sugars to lactic acid which lowers the pH and preserves the product. Carbohydrate added to the protein (which may be fish or meat) acts as the energy source for bacterial growth and may also act as a natural source of lactobacilli. In other preparations the lactic acid forming bacteria are added in the form of a starter culture.

The aim is to produce enough lactic acid to lower the pH to approximately 4.5. At this pH level there should be no problem with *Clostridium botulinum* type E as Wirahadikusumah (1968) has shown that toxin does not develop below pH 5.2. Scandinavian workers (Nilsson and Rydin, 1963; Nilsson, 1970) have recommended the fermentation of fish (and slaughterhouse waste) with 2% malted barley and 18% cereal meals, or molasses and cereal meal, malt and tapioca meal or molasses and tapioca meal. The use of molasses and tapioca is particularly appropriate for tropical areas since they are more readily available. The reaction is temperature dependant and the rate of pH fall depends upon the incubation temperature. During the fermentation of Baltic herring with malt and cereals, Von Hafstan (1974) found that pH 4.5 was reached in two days at 30°C. Successful fermentations were also possible at 37°C but the initial fall in pH was more rapid. Roa (1965) has ensiled minced herring with 10% molasses after inoculation with *Lactobacillus plantarum,* and a similar process has been used in Tasmania as a means of using abalone waste (Olley and James, 1972). Minced abalone viscera with 10% by weight of ground malted barley were inoculated with *L. plantarum* 8531 and incubated at 25°C in plastic dustbins. Considerable evolution of gas occurred and a pH of 4.5 was achieved in four days. A control sample also liquefied without the inoculum and larger scale experiments were carried out when satisfactory products were prepared for feeding trials. The preparation of silage without the use of an inoculum is obviously advantageous and the same workers have prepared successful silages using animal waste (blood or sheep guts) and apple pulp without the addition of an inoculum. Work in South Africa, however, failed to produce a satisfactory silage from minced hake frames and apple pulp although the same fish material, with 10% molasses and an inoculum, was ensiled successfully (Wessels and Labuschagne, 1974).

### *Feeding trials*

Many of the silage products prepared by lactic acid fermentation have been subjected to animal feeding trials, often using poultry. Krishnaswamy *et al.* (1965) prepared fish silage from freshwater fish to which lactose, citric acid, yeast extract and *Streptococcus lactis* were added. The dried silage was found to have comparable biological values to skimmed milk powder when fed to rats. Nilsson and Rydin (1963) refer to poultry feeding trials using silage prepared from a mixture of malt, cereal and minced fish by the action of lactobacilli. The health of the birds and the production of eggs were good and the carcases were of good quality, lacking any unpleasant taste or flavour. Wirahadikusumah (1969), similarly, was concerned more with the quality of the eggs and the meat of the broilers than the nutritional value of the silage. In feeding trials he reported an off-taste in the meat after seven weeks but this was avoided if silage was omitted from the ration one week before slaughter. The same author (Wirahadikusumah, personal communication) showed that silage was more suitable as a protein supplement than a total diet since fish/carbohydrate mixes are not always adequate diets when fed alone. Silage prepared by microbial fermentation was mixed with formic acid silage and tested on chickens (Roa, 1965). Feed efficiencies, food intakes and weight gains of the chickens which were fed the experimental diets were all lower than those of the control groups. The birds on the experimental diet, without vitamin supplementation, developed vitamin E deficiency symptoms.

The literature on the use of ensiled fish products as an animal feed is conflicting. Some authors claim good rates of growth with no problems whereas others report problems of taint and off-flavour. The development of fishy taint in pigs and poultry is well known and silage products must be used carefully (Olley and James, 1972; Hoffman *et al.*).

### *Application in the tropics*

The preparation of fish silage is generally a simple and inexpensive technique which may be applied in the tropics as a means of converting waste fish into animal feed. Products prepared by biological fermentation have the advantage that they do not require the use of imported additives such as acids which are potentially dangerous and expensive. Fermented fish products are produced in large quantities in SE Asia and are familiar to the consumer. However, they suffer a serious handicap in the need to maintain starter cultures; this may prove difficult at the village level, particularly if the waste fish is available only at seasonal intervals. This disadvantage may be removed in cases where an inoculation of lactic acid bacteria is unnecessary; more work is required on this subject.

Although the process is simple and requires little equipment, considerable know-how is necessary and the method must be tried out carefully for each type of raw material and under the particular local conditions. Pilot-scale trials should be carried out in the developing fishery in order to test the technical and economic feasibility of the process. There is a considerable difference between the laboratory experiments described above and the operation of a commercially viable enterprise.

## Acid silage – liquid products

The acid ensilage of fish offal was developed originally from a method invented by A. I. Virtanen in the 1920's (Wirahadikusumah, 1968); sulphuric and hydrochloric acids were used to acidify fish waste and the product was neutralized with chalk. Methods using organic acids, where the pH can be higher and neutralization is unnecessary, have been reviewed by Petersen (1953). Lovern (1965) has assessed the most judicious mixtures of mineral and organic acid for best cost effect. Many developments have subsequently taken place, mainly in the Baltic countries. In Denmark, the production of fish silage using formic acid or formic/sulphuric acid mixtures has increased from 16,000 to 25,000 tons between 1969 and 1972 (Jensen, 1973). In Poland, where mixtures of sulphuric (or hydrochloric) and formic acids, or sulphuric acid and pyrosulphite are used (Sikorski *et al.*, 1969), production is currently running at 7000 tonnes per year. Fish silage has also been produced in Britain and recent developments have been reviewed by Tatterson and Windsor (1974). A symposium on fish silage has also been held recently at the Torry Research Station in Aberdeen.

There are few reports on the preparation of fish silage in the tropics but a 'liquid fishmeal' product has been reported in Sri Lanka (Gunasekera and Lantz, 1955). A method for preparing fish silage using a bitumen-coated metal drum has also been reported in India (Anon, 1964) and more recent work in India will be reported at this meeting (James *et al.*, 1977). An examination of the possibilities for making fish silage in SE Asia has also been recently carried out (FAO, personal communications).

### *Preparation*

In the preparation of an acid silage the choice of preservative is between a mineral acid, mineral acid mixtures, organic acids such as formic or propionic, or mixtures of inorganic acids and organic acids. The choice will depend upon the cost and availability of the acid and the conditions under which the product is prepared. Petersen (1953) and Lovern (1965) have reviewed a number of different methods and their relative merits. Formic acid is more expensive than the common mineral acids but it produces silages which are not very acidic and which do not require neutralization before use. Care must be exercised with silages made from mineral acids and with all acids in the concentrated form. Equipment, tanks and machinery used for production or storage must be acid resistant.

The preservative chosen in recent work in the UK was an 85% solution of formic acid. To completely prevent the growth of spoilage bacteria, moulds and pathogenic bacteria (such as *Salmonella* and *Clostridium botulinum*) . a pH value of 4.0 was chosen (Tatterson, 1976). This pH was achieved by the addition of 3.5% by weight of 85% acid to materials containing appreciable quantities of bone, such as white fish offal; with whole fish somewhat lower pH values resulted. For reasons of safety, reduction of the amount of acid was felt to be inadvisable. Also, for simplicity, different amounts of acid for various materials were thought to be undesirable. However, where production is carried out on a large scale, acid may be saved by careful control of the pH to reduce the cost. The use of different acids and their preservative effect has been studied by Atkinson *et al.* (1974) and the results obtained were similar to the Torry Research Station findings.

Experience in the UK has shown that the successful production of fish silage, irrespective of scale, requires certain conditions:

(1) The material should be reduced in size preferably to pieces no larger than 3 to 4 mm in diameter.

(2) Acid should be thoroughly dispersed throughout the minced fish to avoid pockets of untreated material where bacterial spoilage can continue.

(3) Periodic agitation is necessary to bring about rapid liquefaction.

(4) Temperatures of at least 20°C are desirable, since below this liquefaction takes place rather slowly. The enzymes responsible for liquefaction can become inactivated as temperatures rise but samples heated to 40°C have been found to liquefy rapidly.

Equipment used for silage production can vary considerably. On the small scale it might be sufficient to pulp the raw material, add the acid manually, mix in a suitable container and store in a warm place. For larger scale production, however, a mincer capable of reducing material to the required size is essential, together with suitable heavy duty mixing equipment to ensure that a homogeneous mixture of fish and acid is made. For safety, a pump or measuring device for handling acid is advisable. Suitable tanks are required for initial liquefaction of the fish, together with other tanks for bulk storage of the finished product and formic acid.

After liquefaction, oil removal may be necessary since problems can arise when high oil content silages are fed to animals. To do this it is necessary to raise the temperature of the silage to 65°C to 70°C when coarse suspended solids can be removed by decantation; this is followed immediately by centrifugation to remove the oil. It might sometimes be possible to skim a certain amount of oil from the top of the silage but experience has shown that oil is generally emulsified and that the formation of distinct easily-separable fractions does not occur.

The proximate composition of fish silage will be about the same as that of the raw material, apart from the slight dilution effect of the acid. If oil separation were to be carried out, however, the composition of the de-oiled product would be changed, the components would increase in proportion to the oil removed. Table 1 shows typical compositions of silages made from various materials in the UK: the composition of each oily silage is also expressed on a 2% oil content basis.

In addition to knowing the composition of fish silage it is useful to have a knowledge of the chemical changes taking place during storage. Liquefaction is due almost entirely to autolysis, predominately proteolysis. Results for different silages seem to vary little and, within about a week (if storage temperatures are high enough), up to 70% of the nitrogen present can be soluble.

For both white fish offal silages and those made from oily fish the development of soluble nitrogen has been found to be temperature dependent. Figure 1 shows the results for a silage prepared from sprats; the particularly rapid increases during the first few days' storage for material held at the higher temperatures can be seen.

**Figure 1**

**Soluble nitrogen as a percentage of total nitrogen during storage of sprat silage**

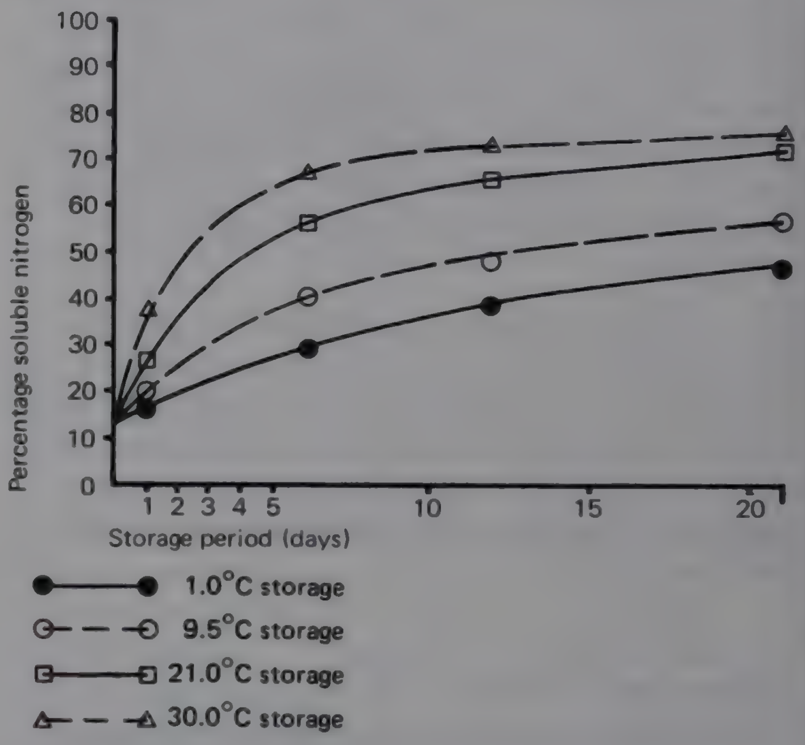


**Figure 2**

**Free fatty acid content of extracted oil during storage of sprat silage**

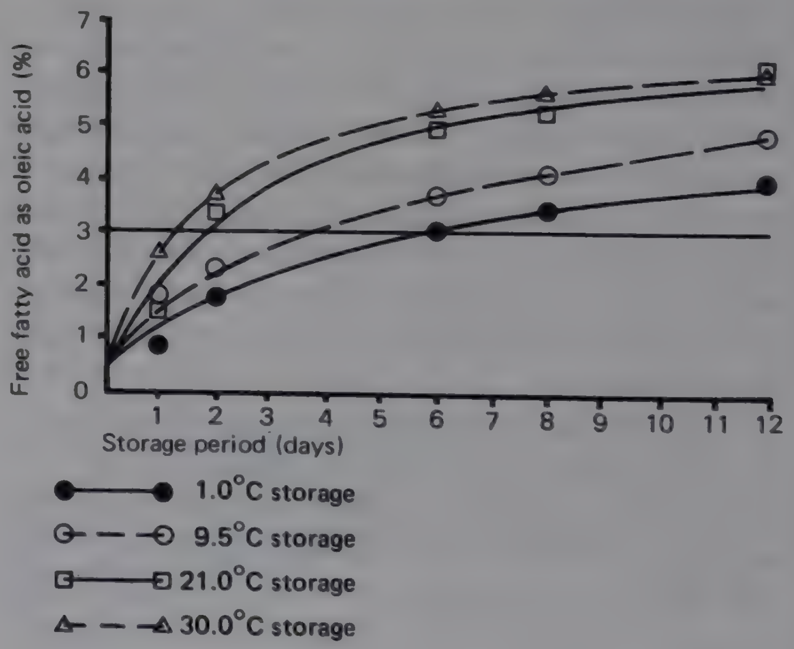


TABLE 1. *Proximate composition of silages made from different materials*

| *Composition (%)* | *White fish offal* | *Herring offal* | *Herring offal (2% oil)* | *Sprats* | *Sprats (2% oil)* | *Sand eels* | *Sand eels (2% oil)* |
|---|---|---|---|---|---|---|---|
| Moisture | 78.9 | 75.4 | 80.8 | 69.4 | 78.0 | 77.7 | 78.8 |
| Oil | 0.5 | 8.7 | 2.0 | 13.0 | 2.0 | 3.4 | 2.0 |
| Ash | 4.2 | 2.6 | 2.8 | 2.2 | 2.5 | 2.4 | 2.4 |
| Nitrogen | 2.40 | 2.16 | 2.32 | 2.48 | 2.78 | 2.46 | 2.50 |
| Apparent protein N x 6.25 | 15.0 | 13.5 | 14.5 | 15.5 | 17.4 | 15.4 | 15.6 |

Major chemical changes also occur in the oil during storage. The free fatty acid content increases, indicating decomposition of the glycerides, whilst oxidative changes cause the oil to darken in colour. Figure 2 shows the increase in free fatty acid in oil extracted from the silage. A free fatty acid content of 3% or less (shown by the line in the figure) is desirable in a good quality oil suitable for refining for edible purposes; the results clearly show the importance of rapid oil removal if quality is to be maintained. Increases are seen to occur most rapidly at the beginning of storage and are temperature dependent (Tatterson, 1976).

### *Feeding trials*

The satisfactory use of fish silage for animal feeding, particularly pigs, has been reported by a number of workers. Jensen (1973) carried out feeding trials in Denmark using pigs and mink. Silage prepared from whole fish using 2% formic acid alone, or 5% sulphuric acid plus 1% formic acid, was found to be nutritionally acceptable when fed to pigs. Alvarez (1972) used rats to evaluate the protein quality of fish silage compared with fish meal and has similarly reported that fish silage can be used as a protein supplement for monogastric animals.

Arneson and Einarsson (1967) used a mixture of cod viscera and fish offal. After digestion the material was concentrated before feeding. Preliminary feeding trials with chickens indicated that the prepared meal was equal to commercial fish meal as judged by weight increase. There are, however, other reports of difficulties in instances where fish silage has a high oil content (McBride *et al.*, 1961); a product with more than 5% oil, on a wet basis, was considered unacceptable as a feed ingredient.

In the United Kingdom, silage prepared from white fish offal, containing 70.3% protein and 3% ether extract on a dry matter basis, has been fed at the 10% dry matter inclusion level to bacon pigs. Weight gains almost as good as those found in pigs fed an equivalent diet containing conventional non-cereal protein were found, and good quality carcases, free of taint, were produced. Equally important has been an attempt to find the maximum level of oil in a feed at which tainting of the carcase does not occur; trials already completed with a silage made from herring offal, containing 42.7% protein and 43.9% ether extract on a dry matter basis, have shown that taint occurred at a dry matter inclusion level of 5% but not at 2.5% (Smith and Adamson, 1976).

Other trials have been carried out in which weaned calves (fed indoors with hay, straw and bruised oats) were compared with groups where the feed included fish silage. As might be expected, at the end of the indoor feeding period, animals fed with the protein supplemented diets had gained the most weight and were in a better condition than those in the group fed only the standard farm diet. However, the importance of this was shown subsequently; at the end of the summer grazing period that followed, the majority of animals fed fish silage had fattened sufficiently for sale, whereas the other group required a further period of feeding before attaining the fat stage. The silage was easily absorbed by the fodder and grain, and the animals accepted the mixture readily (Young and Dunn, personal communication).

### *Application in the tropics*

The process for the production of fish silage is flexible. Silage can be made very cheaply with simple equipment or manufactured on a large scale; fairly sophisticated machinery might be necessary although, even here, it is unlikely that highly skilled labour would be needed unless oil removal was a part of the process. Expensive equipment is required for oil removal but good quality oil is a marketable by-product and commands a price that would, at current rates, soon offset the cost of machinery, provided sufficient quantities were recovered for sale.

Liquid silage can be prepared relatively simply; this is an advantage in the tropical situation but the handling of strong acids at the village level may create problems. The product is also bulky and corrosive and the use of conventional wet silage would seem to be appropriate in situations where the site of production is close to, or has easy access to, the site where the feed will be used. In many tropical countries this is not the case and the storage, handling and transportation of wet silage would be both difficult and expensive, particularly where the raw material is available only at seasonal intervals. A further problem would be the high oil content of many small tropical species. This could complicate the use of a liquid product since there is a risk of taint and other problems during feeding.

Although considerable quantities of liquid silage are produced in Europe, mainly for pig feeding, none is, as yet, produced commercially under tropical conditions. Experiments are currently being carried out in the Solomon Islands by TPI but more information is urgently required on the feasibility of such operations in a number of developing country situations.

## Acid silage – dried products

Liquid fish silage suffers the disadvantage that it is bulky and difficult to handle and, unless formic acid is used as the preservative, neutralization may be necessary. To facilitate easier and cheaper handling and storage, a number of attempts have been made to produce dried material from both fermented products and liquid silage (Krishnaswamy *et al.*, 1965; Atkinson *et al.*, 1974).

This paper will largely deal with the work that has been carried out at TPI over the past few years to develop a dried silage product for use in the tropics. Details of the work have been reported elsewhere (Disney and Hoffman, 1976; Disney *et al.*) and only a resumé will be presented here.

The intention was to prepare a product which could make use of fish at the village level as well as being suitable for more commercial animal production systems. In either event, a more complete animal feed would be produced if an energy source could be incorporated into the silage. Comparatively cheap vegetable products, such as cassava, are often available in the tropics in dried form and it was considered that such agricultural products could be used to prepare a cheap animal food at the village level using simple equipment and requiring a low technological input. The programme was designed to prepare a sun dried fish silage product which could be stored and transported with comparative ease and which would form a complete animal feed.

### *Preparation*

Preliminary laboratory experiments indicated that a combination of mineral acid and formic acid (to combine low pH and bacteriostatic action) provided the most economic acid treatment for the tropical situation (since formic acid is expensive and difficult to obtain it should be used at the lowest practical level possible). Various pH and formic acid concentrations were tested and the levels required were found to be dependent upon the species of fish used and the prevailing climatic conditions. Under extremely poor drying conditions an initial pH of 2.0 with 1% formic acid added was found to be necessary but under more favourable drying conditions, a higher pH and less formic acid would be acceptable.

As a result of the early laboratory experiments a dried product was prepared from frozen red mullet (*Mullus* sp.). The product was made by acidifying the minced fish to pH 2.0, adding 1% formic acid and allowing the mix to hydrolyse. Complete liquefaction occurred in two to four days and dry cassava powder was then added in the ratio 1:1. The resulting paste was air dried in shallow trays and, after drying, the product was broken up by hand.

A variety of dried fish silage products has been prepared in London and in Ghana, Malawi and Brunei. The preparation of silage from tuna waste is also currently being investigated in the Solomon Islands. The purpose of these overseas projects was to investigate the preparation of the dried fish silage product under field conditions, to assess the practical difficulties involved and to prepare material for UK feeding trials.

In Ghana, approximately half a ton of the dried product was prepared for UK feeding trials. Ghanaian herring (*Sardinella aurita*), horse mackerel (*Caranx* sp.) and trigger fish (*Balistes carolinensis*) were used to prepare fish silage. Mincing or cutting by hand were found to be effective although fish cut by hand took six days for complete digestion. With herring and horse mackerel, pH 3.9 (HCl) and 0.5% formic acid were sufficient to prevent spoilage at all stages of production, but the successful digestion of trigger fish required a pH of 2.5 and 1% formic acid, due to the toughness of the skin. However, to ensure the stability of the product during shipment and storage, the material for the UK feeding trials was prepared at pH 3.0 and 1% formic acid was added.

A number of practical difficulties were encountered. Originally, it was intended to use 44 gallon oil drums coated with bitumen but the coating blistered during the hydrolysis phase. It was also difficult to mix large quantities by hand. Consequently the product was prepared in 15 or 20 kg batches in plastic bins. The cassava powder (60% by weight) was added after two days and drying was carried out on plastic sheets over a period of six days. The product was covered with a plastic sheet during showers and overnight.

In Malawi, the work was carried out on a mixed catch of small fish known as chisawasawa or utaka (mixed species of *Haplochromis* and *Lethrinops*). These fish had a high oil content ranging from 8 to 9%. Ground maize and cassava were used as filler materials; using maize alone as the filler material, a product with an oil content of 20% resulted. It was not possible to separate the oil during the digestion phase and cassava powder was added to reduce the total oil content. A variety of products was prepared under different acid treatments and with different levels of filler material. A product prepared at pH 3.0 (sulphuric acid with 0.5% formic acid) containing 20% maize and 10% cassava was found to be the best compromise in terms of the rate of drying, the cost and the final oil content in the product. This combination usually required two to three days to dry to a moisture content below 10%. The final product when added to water had a pH of approximately 4.5.

In the tropics, partially spoiled fish are likely to provide the bulk of raw material for silage production. To determine the effect of using spoiled fish, a number of products were made in Malawi. Fresh fish and fish allowed to spoil for 12 hours and 24 hours at ambient temperature (25 to 30°C) were made into fish silage. A satisfactory product was made from the fresh fish and from the fish which were allowed to spoil for 12 hours. The fish held for 24 hours, prior to mincing and acidification, liquefied very rapidly with considerable gas formation. (These products are discussed later, under feeding trials.) Drying indoors, away from direct sunlight with little air movement, took seven, rather than two or three, days but there was no evidence of moulds, putrefaction or insect larvae. After drying, the product was broken up by hand. With hand mincing and mixing, batches larger than 10 kg were difficult to handle; larger batches would require mechanical equipment.

In the Solomon Islands the intention is to prepare fish silage (either liquid or dried) as a means of utilizing offal and waste from a tuna cannery. Up to four tons of material are available per day but this is insufficient to justify a fishmeal plant. The silage will be fed to pigs as a replacement for imported fish meal, thus saving valuable foreign exchange.

A wide range of products has been prepared both in the UK and overseas. Some of these products, together with their proximate composition, are shown in Table 2. The oil content in the product is dependent upon the raw material used and the protein content is related to the type and amount of filler material. Cassava has been used because it is widely available in the tropics at low cost; other materials such as rice bran, groundnut husks, maize powder and husks (homony chop) have also been used.

Table 3 indicates that both whole fish and fish offal can be used to prepare a satisfactory product. Waste from a shrimp peeling operation was also used but the high levels of acid required may prohibit the use of this material. A product using formic acid only may be better but this was not attempted.

TABLE 2. *Proximate analysis of fish silage products (whole fish)*

| *Material used* | *Acid treatment* | *Filler material (fish: filler ratio)* | *Moisture %* | *Protein (N × 6.25) %* | *Oil %* | *Ash %* |
|---|---|---|---|---|---|---|
| Herring (UK) | 3% HCOOH | Cassava (1:1) | 10.3 | 12.4 | 9.1 | 4.0 |
| Herring (UK | pH 2.0 (HCl) + 1% HCOOH | Cassava (1:1) | 10.2 | 11.3 | 8.6 | 3.9 |
| Haplochromis (Uganda) | pH 2.0 (HCl) + 1% HCOOH | Cassava (1:1) | 9.3 | 12.9 | 2.7 | 5.4 |
| Herring (Ghana) | 3% HCOOH | Cassava (1:1) | 9.0 | 14.9 | 0.9 | 3.9 |
| Herring (Ghana) | pH 2.0 (HCl) + 1% HCOOH | Cassava (1:1) | 8.8 | 14.5 | 1.1 | 4.1 |
| Horse mackerel (Ghana) | pH 3.0 (HCl) + 1% HCOOH | Cassava (1:0.6) | 9.8 | 19.8 | 5.1 | – |
| Mullet (North Africa) | pH 2.0 (HCl) + 1% HCOOH | Cassava (1:1) | 11.2 | 13.0 | 1.7 | – |
| Mullet (North Africa) | pH 2.0 (HCl) + 1% HCOOH | Cassava and groundnut husk (1:0.5:0.5) | 9.9 | 16.3 | 1.3 | 5.3 |
| Mullet (North Africa) | pH 2.0 (HCl) + 1% HCOOH | Cassava and maize (1:0.5:0.5) | 10.7 | 14.7 | 0.6 | 4.5 |
| Chisawasawa/utaka (Malawi) | pH 3.0 ($H_2SO_4$) + 0.5% HCOOH | Cassava and maize (1:0.1:0.2) | 9.2 | 28.8 | 7.8 | – |
| Duck fish (Thailand) | pH 3.8 (HCl) + 1% HCOOH | Cassava (1:1) | 8.1 | 13.1 | 0.7 | 4.4 |
| Trigger fish (Ghana) | pH 3.0 (HCl) + 1% HCOOH | Cassava (1:1.7) | 13.4 | 13.3 | 1.4 | 5.9 |
| Chub mackerel (Brunei) | pH 3.0 ($H_2SO_4$) + 0.5% HCOOH | Rice bran and maize (1:0.5:0.5) | 10.7 | 18.5 | 6.8 | 5.6 |

TABLE 3. *Proximate analysis of fish silage products (fish offal)*

| *Material used* | *Acid treatment* | *Filler material (fish: filler ratio)* | *Moisture %* | *Protein (N × 6.25) %* | *Lipid %* | *Ash %* |
|---|---|---|---|---|---|---|
| *Red snapper* (Argentina) | | | | | | |
| Whole fish | pH 3.0 (HCl) + 1% HCOOH | Cassava (1:1.7) | 9.9 | 18.0 | 2.6 | 6.9 |
| Head and guts | pH 3.0 (HCl) + 1% HCOOH | Cassava (1:1.7) | 10.1 | 15.4 | 3.7 | 8.4 |
| Skeleton (incl. heads) | pH 3.0 (HCl) + 1% HCOOH | Cassava (1:1.7) | 11.3 | 14.1 | 4.0 | 12.1 |
| Head only | pH 3.0 (HCl) + 1% HCOOH | Cassava (1:1.7) | 8.5 | 17.5 | 4.8 | 9.3 |
| *Tope* (UK) | | | | | | |
| Gut | pH 2.0 (HCl) + 1% HCOOH | Cassava (1:1) | 8.3 | 10.2 | 8.3 | 2.4 |
| Flesh | pH 2.0 (HCl) + 1% HCOOH | Cassava (1:1) | 8.8 | 17.3 | 0.4 | 2.7 |
| Offal | pH 2.0 (HCl) + 1% HCOOH | Cassava) (1:1) | 11.2 | 17.0 | 0.2 | 5.5 |
| Head | pH 3.0 (HCl) + 1% HCOOH | Cassava (1:1.7) | 8.5 | 17.5 | 4.8 | 9.3 |
| *Shrimp* (UK) | pH 3.0 (HCl) + 0.5% HCOOH | Cassava (1:0.3) | 8.6 | 15.6 | 11.0 | 7.5 |

TABLE 4. *Proximate analysis of fish silage products made from red mullet to give different protein levels*

| *Acid treatment* | *Filler material (fish: filler ratio)* | *Moisture %* | *Protein (N × 6.25) %* | *Lipid %* | *Ash %* |
|---|---|---|---|---|---|
| pH 3.0 (HCl)<br>+ 1% HCOOH | Cassava<br>(1:0.43) | 9.7 | 23 | – | 10.1 |
| pH 3.0 (HCl)<br>+ 1% HCOOH | Cassava<br>(1:0.54) | 11.1 | 20 | – | 6.2 |
| pH 3.0 (HCl)<br>+ 1% HCOOH | Cassava<br>(1:0.67) | 10.9 | 19 | – | 6.3 |
| pH 3.0 (HCl)<br>+ 1% HCOOH | Cassava<br>(1:0.82) | 12.0 | 17 | – | 5.4 |
| pH 3.0 (HCl)<br>+ 1% HCOOH | Cassava<br>(1:1) | 10.1 | 15 | – | 5.1 |

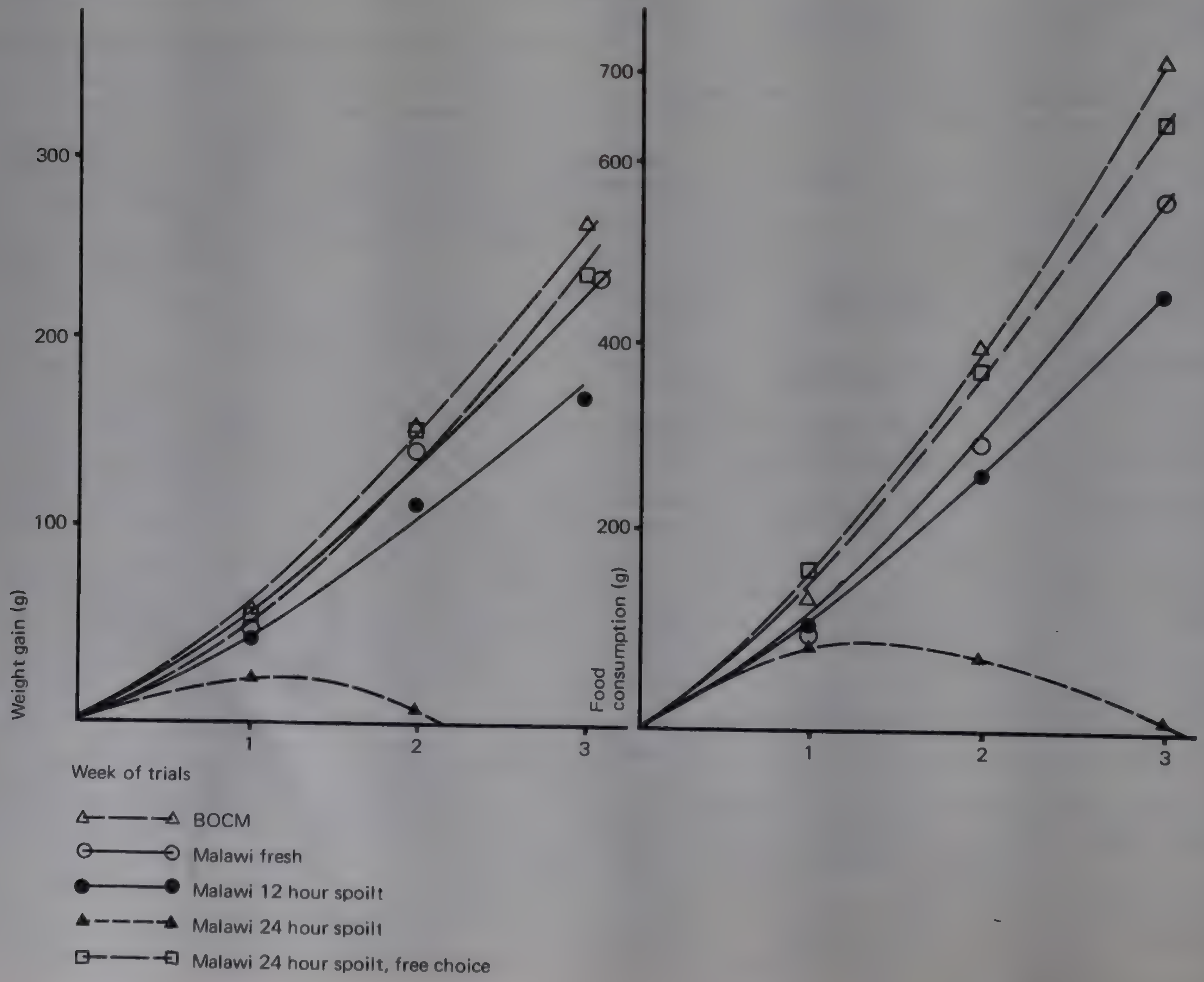
Table 4 illustrates one of the potential advantages of this technique, namely the ability to tailor the product to meet the needs of the animal feed industry. The material prepared for poultry feeding trials purposely contained 20% protein but the protein content may be modified by altering the proportion of filler material.

### *Feeding Trials*

Analysis of the dried silage products (including amino acid profiles), limited rat feeding experiments and 11 feeding trials using poultry have been reported elsewhere (Disney *et al.*; Hoffman *et al.*). The results of the feeding trials will therefore only be summarized. A commercial diet was used as control and all silage products were prepared to contain 20% protein. Figure 3 shows typical growth and food consumption curves of the chicken feeding trials.

The product, prepared in Malawi from fresh fish and containing maize and cassava, gave food intakes and weight gains slightly lower than the BOCM control but with a higher feed efficiency. The product prepared from stale fish (12 hours) resulted in reduced growth whilst the product made from completely spoiled fish (24 hours) caused the chicks to die. However, feeding trials in which silages made from fresh and stale fish from Malawi

**Figure 3**
**Poultry feeding trials**



were fed as a free choice with the BOCM control showed that the Malawi products were palatable and the chicks grew well; equal quantities of the test and control diets being consumed. The materials from Ghana when fed alone gave poor growth but subsequent experiments showed that the poor performance was overcome if they were pre-mixed with the control diet in equal amounts. Comparable gains and better feed efficiencies were obtained than with the control diet alone.

During the early feeding trials it was hoped that the dried fish silage product would represent a complete diet but a number of the products resulted in poor growth. A number of possible causes were investigated. Formic acid and cassava were both shown to be palatable and acceptable, and the experiments on vitamin E and thiamin deficiency were inconclusive (Disney *et al.;* Hoffman *et al.*).

A survey of the literature on the use of fish silage as an animal feed indicates that evidence on the nutritional value (and the off-flavour problem) is conflicting. Several reports conclude that formic acid silage is a satisfactory feed supplement but questions of palatability, off-flavour, the effect of oil content and the need for vitamin supplementation have all been raised. The present work adds to the conflicting data on the value of silages. The products prepared in both Ghana and Malawi were all suitable as feed supplements but only the fresh Malawi material approached suitability as a complete diet.

### *Cost of production*

The cost of producing the dried fish silage was investigated in both Ghana and Malawi but the calculations were complicated by the fluctuations in price of both the fish and the filler materials.

In Ghana, using the wholesale price for fish and cassava, and including estimated costs for equipment, labour and transport, it was calculated that one ton of product containing 20% protein would cost between £35 and £60. By comparison, fish meal was imported at that time (1972) at £108 per ton (60% protein minimum). In terms of protein content the fish silage product is not competitive, but the production cost includes fish purchased at the wholesale price; in times of glut the fish would cost substantially less. The silage product also contains the energy component of an animal feed which must be added to fish meal at additional cost.

In Malawi the calculation was somewhat simpler because the price of the raw materials was more stable. Fish were purchased at the wholesale price; 10 kg fish together with 2 kg maize yielded 5.5 kg of product containing 30% protein. Including the labour and equipment costs the dried silage could be produced for £75 per ton. This may be compared with the very high price (in 1973) of imported fish meal of £250 (this price has subsequently fallen considerably).

Clearly the feasibility of production must be investigated in each situation where it may be suitable as a means of utilizing waste fish. From the information collected in Ghana and Malawi it would appear that a commercially viable operation may be possible under certain circumstances.

### *Application in the tropics*

The preparation of a dried silage product requires little skill and the equipment is very cheap. It is also labour intensive and seems well suited to the developing country situation. The method suffers from the usual disadvantage encountered during the preparation of liquid silage products, ie it involves the handling of corrosive acids, but dried silage has the advantage over liquid products in that the final product can be fed more easily and it is more easily handled, transported and stored.

Feeding trials with poultry suggest that the product could be used as a source of protein and energy for compounding feeding rations for poultry. It is not advisable to use the product as a complete diet until more work using fresh fish has been carried out. Silages made from stale fish cannot be used as a complete diet but they do offer a substitute for a proportion of imported protein concentrates.

## Conclusions

In tropical countries large quantities of fish are undoubtedly wasted, particularly in small-scale fisheries. It is obvious that methods of utilizing these fish are urgently needed and that ideally this material should be used as human food. Research is being conducted in many countries to make this possible but, in the shorter term, the fish can be converted into animal feed. This could considerably reduce animal feed imports in many developing countries.

In situations where fishmeal production is not possible the preparation of fish silage represents one alternative means of utilizing waste fish. Each different silage product considered in this paper has certain points in its favour as well as some disadvantages. Local conditions, such as the type of fish available, the cost of materials and the structure of the fish and animal feed industries, could determine which technique is most appropriate. Despite the disadvantage of using acids in rural communities the authors feel that acid silage offers the most promise. Liquid silage may be more suitable for feeding to pigs but dried products have a future in other situations. On the other hand, biological fermentations possibly offer the most likely means of producing a human food from waste fish. Further research effort is required under tropical conditions to assess the technical and economic feasibility of silage production by both methods.

## References

**Anon.** (1964) Fishery products of commerce – fish and silage. *Indian Fish. Bull.*, **11** (3), 12–13.

**Alvarez, R. J.** (1972) A comparative study of the nutritional value of the protein from ensiled fish. *Rev. Cubana Cienc. Agric.*, **6**, 219–222.

**Arnesen, T. V., Einarsson, H. & Einarsson, G.** (1967) Hagnýting á slógi. *Jimarit Verkfraedings Felogs Islands,* 52, 247.

**Atkinson, A., Lamprecht, E. & Misplon, D.** (1974) In: 28th *Ann. Rep. Fish. Ind. Res. Inst., South Afr.,* p. 44.

**Disney, J. G., Cole, R. C., Francis, B. J. & Rice, R.** Development of a fish silage/carbohydrate animal feed for use in the tropics. I Methods of preparation. Submitted for publication in *Trop. Sci.*

**Disney, J. G. & Hoffman, A.** (1976) A dried fish silage product. *Pap. pres. Torry Res. Stn. Symp. on 'Fish Silage', Aberdeen,* 27 May 1976, 14 pp.

**Gunasekera, C. & Lantz, A. W.** (1955) Liquid fish 'meal'. *Biological and Technical Fisheries Research Station, Colombo, Sri Lanka, Prog. Rep.* No. 1, pp. 7–10.

**Hoffman, A., Olley, J., Barranco, A. & Clucas, I. J.** Development of a fish silage/carbohydrate animal feed for use in the tropics. II Animal feeding trials. Submitted for publication in *Trop. Sci.*

**IDRC** (1975) *Stable tropical fish products.* Report on a workshop held in Bangkok, Thailand, 8–12 October 1974. Ottawa, Canada: IDRC, 28 pp.

**James, M. A., Iyer, K. M. & Nair, M. R.** (1977) Comparative study of fish ensilage prepared by microbial fermentation and formic acid ensilage. In: *Proc. Conf. Handl. Proc. Mark. Trop. Fish.* London: TPI.

**Jensen, J.** (1973) Report to DANIDA Fiskeriministeriets Forsogslaboratorium, Denmark.

**Krishnaswamy, M. A., Kodkol, S. B. & Revankar, G. D.** (1965) Nutritional evaluation of an ensiled product from fish. *Can. J. Biochem.,* **43**, 1879–1883.

**Lovern, J. A.** (1965) Trash fish – is there any money in it? *World Fish.,* **14** (7), 85–86, 88.

**McBride, J. R., Idler, D. R. & MacLeod, R. A.** (1961) The liquefaction of British Colombia herring by ensilage, proteolytic enzymes and acid hydrolysis. *J. Fish. Res. Board. Can.,* **18** (1), 93–112.

**Meinke, W. W.** (1974) The potential of the by-catch from shrimp trawlers. In: *Fishery products* (ed. R. Kreuzer). *Proc. Tech. Conf. Fish. Prod., Tokyo,* 1973, pp. 233–237. Surrey, England: Fishing News (Books), 462 pp.

**Nilsson, R.** (1970) In: Evaulation of novel protein products (eds. A. E. Bender, R. Kihlberg, B. Löfqvist and L. Munck) *Proc. Int. Biol. Programme and Wenner-Gren Centre Symp. Stockholm,* 11–13 September 1968. Oxford: Pergamon.

**Nilsson, R. & Rydin, C.** (1963) Fermentation as a means of preserving organic material. *Acta Chem. Scand.,* **17** (Suppl.), 173–179.

**Olley, J. & James, D.** (1972) Rural Research. *CSIRO Rep.* No. 77.

**Petersen, H.** (1953) Acid preservation of fish and fish offal. *FAO Fish. Bull.,* **6**, 18–26.

**Roa, P. D.** (1965) Ensilage of fish by microbial fermentation. *Fish. News Int.,* **4** (3), 283–284, 286.

**Sikorski, Z. E., Dunajski, E. & Kobylinski, S.** (1969) The reduction of fish in Poland. *FAO Fish. Tech. Pap.* No. 69, 17 pp.

**Smith, P. & Adamson, A. H.** (1976) Pig feeding trials with white fish and herring liquid protein (fish silage). *Pap. pres. Torry Res. Stn. Symp. on 'Fish Silage',* Aberdeen, 27 May 1976.

**Stanton, W. R. & Yeoh, Q. L.** (1977) Low salt fermentation method for conserving trash fish waste under SE Asian conditions. In: *Proc. Conf. Handl. Proc. Mark. Trop. Fish.* London: TPI.

**Tatterson, I. N.** (1976) The preparation and storage of fish silage. *Pap. pres. Torry Res. Stn. Symp. on 'Fish Silage',* Aberdeen, 27 May 1976.

**Tatterson, I. N. & Windsor, M. L.** (1974) Fish silage. *J. Sci. Food Agric.* **25**, 369–379.

**Von Hafstan** (1974) *Preservation of fish and other protein rich products by lactic acid fermentation.* Sweden: Salen Interdevelop AB.

**Wessels, J. P. H. & Labuschagre, S.** (1974) In: 28th *Ann. Rep. Fish. Ind. Res. Inst., South Afr.,* p. 50.

**Wirahadikusumah, S.** (1968) *Lantbrukshoegsk. Ann.,* **34**, 551.

**Wirahadikusumah, S.** (1969) The effect of fish silage on the quality of hens' eggs and meat of broilers. *Lantbrukshoegsk. Ann.,* **35**, 823.

# Fish product development in India

**G. K. Kuriyan**

Central Institute of Fisheries Technology, India

## Summary

The collapse of the Indian trade in traditional dry/cured fishery products with the neighbouring countries, at the end of the World War II, was followed by its regeneration on modern lines catering to the sophisticated markets in the West. There is now a greater awareness of the diversification of fishery products and markets. Research work has been initiated in different laboratories in the country to devise ways and means to turn out new products which can have potential markets within the country and abroad. The results have been encouraging and many new products (frozen, canned and speciality products involving minced fish meat and hydrolysed meat), new cured products of extended shelf life and by-products have been developed.

## Résumé

L'effondrement du commerce indien des produits de la pêche séchés/salés traditionnels avec les pays voisins intervenu à la fin de la seconde guerre mondiale, a fait place à une réorganisation fondée sur des principes modernes, pour approvisionner les marchés discriminants des Etats Occidentaux. On connaît mieux maintenant la diversification des produits de la pêche et des marchés. Un travail de recherche a été entrepris dans différents laboratoires du pays pour imaginer des voies et des moyens en vue de la fabrication de nouveaux produits ayant des marchés potentiels dans le pays et à l'étranger. Les résultats ont été encourageants et plusieurs nouveaux produits (des produits congelés et en conserves et des specialités comportant de la chair de poisson hachée et de la chair hydrolysée), de nouveaux produits salés de temps de conservation plus long et des sous-produits ont été créés.

## Resumen

Al final de la Segunda Guerra Mundial, el comercio de productos pesqueros, curados en seco por métodos tradicionales, entre la India y sus países vecinos sufrió un colapso. Posteriormente, dicho comercio se regeneró con modernas líneas de abastecimiento hacia los sofisticados mercados del Oeste. En la actualidad, existe un mayor conocimiento de las posibilidades de diversificación de los productos pesqueros y sus mercados. Se han iniciado trabajos de investigación en diferentes laboratorios del país para descubrir formas y medios de elaborar nuevos productos, que puedan tener mercados potenciales dentro y fuera del país. Los resultados han sido alentadores, y se han desarrollado muchos nuevos productos (congelados, enlatados y especialidades a base de carne de pescado picada y de carne hidrolizada), nuevos productos curados con larga duración de almacenamiento y subproductos.

## Introduction

The voluminous trade in traditionally processed dry/cured fishery products with India's neighbouring countries suffered a severe set back during the post World War II period. Closely following this, there emerged a drive to regenerate the industry which, when it actually took place, witnessed a thorough shift in its produce from dry/cured products to more sophisticated ones, such as frozen and canned. The market also changed from east to west. This modern industry, which made a very modest beginning with an export of 13,106 kg of frozen prawns in 1953, grew in stature to the extent of contributing as much as 46,831 kg in 1975 earning Rs* 736.127 million and is being looked upon with renewed hope for the future. This spectacular achievement within such a short time has been possible thanks to the simultaneous development efforts in the fields of fishing and fish processing.

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*1 Indian Rupee (Rs) = £0.06 at June 1976

TABLE 1. *Volume of prawns and total marine landings in India from 1970 to 1975 (tonnes)*

| *Year* | *1970* | *1971* | *1972* | *1973* | *1974* | *1975* |
|---|---|---|---|---|---|---|
| Prawns (penaeid) | 89,812 | 72,109 | 77,492 | 136,680 | 114,934 | 145,000 |
| Total landing | 1077,466 | 1161,389 | 976,510 | 1230,859 | 1217,797 | 1310,000 |

The mainstay of the modern fish processing industry has been prawns which, on average, contribute 10% of the total marine landings in the country (Table 1). With a steady market existing for frozen and canned prawns, the industry had, in the past, been reluctant to diversify; first, because the fate of a new commodity in international markets was uncertain and, second, because the technology of production of many products, which could have had a demand within the country and abroad, was not known.

It has been estimated that, of the total fish landed in the country, nearly 60% is consumed fresh and the rest is available for different types of processing and preservation. With an ambitious programme of increasing the fish landing to 3 million tonnes by the end of the Fifth Five Year Plan from the present 1.3 million tonnes (1975), the quantity of fish available for processing is bound to increase considerably.

The modern seafood processing industry has developed solely as an export-orientated one. It is now clear that the future of the industry will depend entirely on diversification of the range of products, as well as the markets, both within the country and abroad. Of late, there has been a greater awareness of this problem and significant contributions have been made by research laboratories in the development of new fishery products. The Indian Council of Agricultural Research has also launched an All-India Co-ordinated Research Project on 'Transportation of Fresh Fish and Utilization of Trash Fish'; there are different representative centres along the Indian coastline with the co-ordinating centre at Cochin.

## Product Development

### *Freezing*

Fillets, made from fish which are generally not considered as table fish, eg kilimeen (*Nemipterus japonicus*), catfish (*Trachyurus* spp.), scianids etc, when frozen and made into consumer type packs, have been found to be in great demand on the domestic market. Similarly, flesh of other cheap varieties of fish, which do not find a ready market, can be extruded and made into frozen consumer packs. Jewfish, catfish, shark, skate, ray, anchoviella, pomfret, seer, sole, tunny, threadfin, ribbonfish, eel, perch etc, when frozen in different forms (eg whole, fillets, round chunks etc), can have potential export markets.

### *Canning*

For a number of reasons, Indian canned prawns are among the best available in international markets; however, the unprecedented increase in the cost of raw material and containers and the world-wide decline in demand for canned prawns have resulted in a decline in the prawn canning industry. This is illustrated in Table 2.

TABLE 2. *The quantity and value of canned prawns in marine products export from 1971 to 1975*

| *Year* | *1971* | *1972* | *1973* | *1974* | *1975* |
|---|---|---|---|---|---|
| Quantity % | 5.48 | 2.7 | 4.51 | 3.25 | 0.49 |
| Value % | 7.60 | 3.62 | 6.58 | 6.27 | 0.56 |

Diversification is, therefore, the most urgent need of the canning industry. Marine fish landings in India are composed of a large number of species, many of which are popular in canned form in overseas markets. Oil sardines (*Sardinella longiceps*), which account for about 25% of the total marine landing, are not, at present, fully utilized as a food fish. Although there is an installed capacity for producing nearly one hundred thousand cans per day, India has not made much headway in this field. The small amount of the canned sardine produced is used exclusively by the armed forces. There are several reasons contributing to this particular phenomenon; the most prominent among them is the very high cost of the containers and the filling medium (oil). To overcome this problem to a significant extent in India, a method for canning sardine in its own juice (called the 'natural pack') has recently been reported (Nair *et al.*, 1974); besides dispensing with the use of the costly filling medium, this also saves labour. To provide an impetus to the export of canned sardine, the Marine Products Export Development Authority has announced a scheme where 20% of the FOB value will be given as subsidy to the exporter. Methods have also been developed for smoking and canning sardine in different types of media (Nair *et al.*, 1976).

The next most abundant species is the Indian chub mackerel (*Rastrelliger kanagurta*) which has been found to be quite suitable for canning. Technology for canning mackerel in oil has already been developed (Balachandran and Bose, 1964a). Also, extensive investigations have been carried out on storage of mackerel in ice, prior to canning, and its effect on the quality of the products (Madhavan *et al.*, 1970). However, the most significant method is one recently reported for canning mackerel as skinless and boneless fillets (Saralaya *et al.*, 1975). Mackerel has also been canned naturally.

Yet another species, which has a very high potential yield from Indian waters, is the anchoviella (*Engraulis commersoni*) which is also quite acceptable in canned form. Methods have been developed for canning these in different media, eg oil and sauces, and the response from consumers at home has been good after pilot-scale sales programmes. Tuna, seer, and catfish are other species for which there also exists a market abroad; processes for canning most of these fish are already available. The canning process for smoked eel has also been standardized (Kandoran *et al.*, 1971).

Mussel (*Mytilus* sp.), clams (*Vellorita* sp. and *Meretrix* sp.) and oyster (*Cressostrea* sp) are almost untapped resources. They can well and hold a very good potential for overseas trade. Suitable methods have been developed for canning clams and mussels, which take care of the problems of grittiness that are generally met when such items are canned (Balachandran and Nair, 1975).

Crabs (*Scylla serrata* and *Portunus* sp.) are good raw materials for canning; the main problem is the discolouration of the meat during storage in cans. This has been successfully overcome by allowing proper bleeding and cleaning of crab meat before cooking; in this way, the copper and iron contents, the factors which cause blackening, come down to a level at which their effect becomes insignificant.

### *By-catch utilization*

Whereas the problems faced by the organized fish processing industry can be solved by the proposed diversification programmes, the problem of utilization of trash fish still remains. Sporadic reports had been appearing about their probable utilization as fish protein concentrate (Ismail *et al.*, 1968), as ensilage for cattle and poultry feed (James, 1966), in fish flakes and soup powder (Venugopalan and Govindan, 1967) etc until the launching of the All-India Co-ordinated Research Project on 'Utilization of Trash Fish'. On implementation of the project programme, a concerted effort was made in the country, at its different operational centres, for devising the best means for their utilization. The project has progressed well and a number of products have been developed, some of which have already been taken up by the industry although only on a limited scale. Suitable methods have been worked out for the preparation of fish wafers, fish soup powder and tablets etc. A process has been developed for the production of functional fish protein concentrate as well as the preparation of fish hydrolysate using the enzymes papain and pepsin successively. Bacteriological peptone, prepared from trash fish, has been found to be equal in all its characteristics to the imported brands of 'Bacto' peptones (Prabhu *et al.*, 1963). A number of products prepared with fish meat in different forms (eg meat flakes, minced meat or partially hydrolysed meat such as canned fish paste, fish cake etc) have also been developed under the project. Another item of importance is a solid food mix prepared with fish ensilage using defatted rice bran and other vegetable products. Prabhu *et al.* (1975) have reported a method for preparation of a beverage incorporating trash fish meat hydrolysates.

Sun drying of fish and prawns is one of the most extensively practised forms of fish preservation; however, it is only recently that mechanical means of drying fish have been seriously considered. Prabhu *et al.* (1963) and Balachandran (1969) have reported on drying fish using artificial driers. Based on the data obtained from these studies, a tunnel drier, which can handle one tonne of raw material, was designed; it has been constructed and is now operating for the commercial drying of fish. Other achievements in the field of mechanical drying are a method developed for simultaneous cooking, drying and shelling of prawns using a rotary drum drier (Balachandran and Bose, 1964a), and a method for drying raw peeled and deveined products using a tunnel drier (Balachandran and Bose, 1964b).

Fish curing was once practised extensively along the Halabar coast but this has now decreased. The products had a limited shelf life and an unattractive appearance; to prevent both these defects occurring, extensive research has been carried out. Rubbing the normally cured fish with salt containing 3% sodium propionate has been found to be very effective in preventing mould growth and attack by red halophilic bacteria; this gives the product an attractive appearance and an extended shelf life of over 9 months (Valsan, 1974). Improvement of the traditional method of Colombo curing of mackerel, by incorporating sodium benzoate (Balachandran and Muraleedharan, 1975), and of other fishes, using tartaric acid and garlic as preservatives (Devadasan *et al.*, 1975a), and the development of processes for smoke curing different types of fish (Solanki *et al.*, 1970; Devadasan *et al.*, 1975b) etc are significant achievements.

A very simple method has been developed, for the preparation of edible fish flour from non-fatty fish, with a view to incorporating this as a cheap dietary supplement for combating the protein malnutrition of the rural population. The method consists of cooking the fish, followed by drying, pulverization and partial removal of the bones. Feeding trials have been carried out with the help of certain health agencies and have given promising results.

Processing fish invariably produces waste; proper utilization of this waste can support an auxiliary industry. It is estimated that more than 40,000 tonnes of waste, comprising prawn shell and head, are turned out every year by the prawn processing industry. Prawn shell contains chitin, which on deacetylation yields chitosan, an industrial chemical with wide and varied potential applications (eg sizing textiles, water and wine clarification, as an adhesive and base for chromatography etc). In addition, this waste also contains a good amount of protein which can be recovered and put to proper use. New methods have been developed for the isolation of chitosan (Radhakrishnan and Prabhu, 1971; Nair and Madhavan, 1974) and also for the recovery of protein (Prabhu *et al.*, 1975).

Dried shark fins are an Indian export which, in the importing countries, are further processed to extract the fin rays. Processing the rays, in India, will ensure a saving in the freight as well as generating employment. A very simple method for extracting rays from the fin has been developed (Nair and Madhavan, 1974) as a cottage industry, particularly for meeting the internal demand for fin rays.

The body oil from sardine contains highly unsaturated fatty acids. Due to this property, it has been found that, after proper modification, it can be used for a number of industrial applications. Methods have been reported from various institutes for the preparation of a mineral rubber used in the rubber compounding industry, a base for paints and printing ink and a lubricating oil using good quality sardine oil.

## References

**Balachandran, K. K.** (1969) An accelerated method of hot air drying of fish. *Fish Technol.*, 6 (2), 124–128.

**Balachandran, K. K. & Bose, A. N.** (1964a) The dehydration of prawns in tunnel driers. *Fish Technol.*, 2 (1), 126–130.

**Balachandran, K. K. & Bose, A. N.** (1964b) *Proc. Indo-Pac. Counc.*, II, 272.

**Balachandran, K. K. and Muraleedharan, V.** (1975) Studies on Colombo – curing of mackerel (*Rastrelliger kanagurta*). *Fish Technol.*, 12 (2), 145–150.

**Balachandran, K. K. & Nair, T. S. U.** (1976) Diversification in canned fishery products – canning of clams and mussels in oil. In: *Proc. Symp. Fish Proc. Ind. India*, 13–14 Feb. 1975, pp. 53–55. Mysore: AFST.

**Devadasan, K., Muraleedharan, V. & Joseph, K. G.** (1975a) Pickle curing of fish using tartaric acid and garlic as preservatives. *Fish Technol.*, 12 (2), 156–159.

**Devadasan, K., Muraleedharan, V. & Joseph, K. G.** (1975b) Studies on smoke curing of tropical fishes. *Fish Technol.*, 12 (1), 77–80.

**Ismail, P. K. Madhaven, P. & Pillai, V. K.** (1968) Preparation of fish protein concentrate. *Fish Technol.*, 5 (1), 53–59.

**James, M. A.** (1966) Ensiled products from fish by microbial fermentation. *Fish Technol.*, 3 (1), 38–43.

**Kandoran, M. K., Solanki, K. K. & Venkataranan, R.** (1971) Canning of smoked eel. *Fish Technol.* 8 (1), 98–100.

**Madhavan, P., Balachandran, K. K. & Choudhuri, D. R.** (1970) Suitability of ice-stored mackerel and sardine for canning. *Fish Technol.*, 7 (1), 67–72.

**Madhavan, P. & Nair, K. G. R.** (1974) Utilization of prawn waste – isolation of chitin and its conversion to chitosan. *Fish Technol.*, **11** (1), 50–53.

**Nair, K. G. R. & Madhavan, P.** (1974) Shark fin rays-technology of extraction. *Fish Technol.*, **11** (1), 60–63.

**Nair, T. S., Madhavan, P., Balachandran, K. K. & Prabhu, P. V.** (1974) Canning of oil sardine (*Sardinella longiceps*) – natural pack. *Fish Technol.*, 11 (2), 151–155.

**Nair, T. S. U., Balachandran, K. K. & Madhavan, P.** (1976) *Fish Technol.* **13** (2), (in press).

**Prabhu, P. V., Swaninathan, M., Venkataraman, R. & Bose, A. N.** (1963) Investigations on dehydration of some commercial fish in India. *IPFC Curr. Affairs Bull.*, No. 37, 1–12.

**Prabhu, P. V., Radhakrishnan, A. G. & James, M. A.** (1975) Beverage preparation from fish hydrolysates. *Fish Technol.*, 12 (2), 127–130.

**Radhakrishnan, A. G. & Prabhu, P. V.** (1971) *Res. Ind.*, 16 (4), 265.

**Saralaya, K. V., Parasuram, P. & Rai, B. S.** (1975) Studies on canning of mackerel fillets in oil. *Fish Technol.*, 12 (2), 120–126.

**Solanki, K. K., Kandoran, M. K. & Venkataraman, R.** (1970) Studies on smoking of eel fillets. *Fish Technol.*, 7 (2), 169–176.

**Valsan, A. P.** (1974) *Invent. Intell.*, 9 (6), 215.

**Venugopalan, V. & Govindan, T. K.** (1967) Utilization of trash fish. 1 Preparation of fish flake. *Fish Technol.*, 4 (1), 35–43.

# Minced fish as an ingredient in food combinations

**M. A. Steinberg, J. Spinelli and D. Miyauchi**
Department of Commerce, USA

## Summary

Fish muscle from a number of species, lean and oily, and fresh and frozen, has been used as partial replacement for lean beaf in commercially processed meat products such as frankfurters (meat sausages), meat loaves and pork sausages. Hake (*Merluccius productus*) held in frozen storage for 12 months was used at replacement levels of 5, 10 and 15 per cent by weight for meat in sausages. A trained taste panel could not distinguish between the extended sausages and the all-meat control when fish was present at the 5 per cent level. In commercially produced products using combinations of fish (*Sebastes* sp.), soy and poultry, and fish alone, replacement of lean beef at concentrations up to 15 per cent could not be detected by trained taste panels on the basis of flavour. Fish did produce softer sausages that were still highly acceptable.

Preliminary work on the preparation of drum-dried mixtures of pre-cooked rice and hake indicates that a very acceptable beverage similar to traditional drinks, prepared commercially and at home in some South American countries, is practical. Short-term storage at ambient temperatures indicated the development of no fish flavours in preparations containing fish at a level of 20 per cent of solids.

## Résumé

Le tissu musculaire d'un certain nombre d'espèces de poissons, maigres ou gras, frais ou conservés par congélation, ont été utilisés en remplacement partiel de boeuf maigre dans des préparations de viandes commercialisées telles que les francfort (saucisses de viande), les hachis de viande en croûte et les saucisses de porc. Du merlu (*Merluccius productus*) conservé par congélation pendant 12 mois a été utilisé à des taux de remplacement de 5, 10 et 15 pour cent du poids de viande dans les saucisses. Un groupe de spécialistes chargés de goûter le produit n'a pu faire de distinction entre les saucisses comportant de la chair de poisson et celles ne contenant que de la viande lorsque la quantité de poisson était de 5 pour cent. Dans les produits commerciaux provenant des mélanges de poisson (*Sebastes* sp.), de soja et de volaille, et de poisson seulement, le remplacement de la viande maigre de boeuf jusqu'à des concentrations de 15 pour cent ne pouvaient être détectées par un groupe de spécialistes chargés de goûter le produit. Le poisson fournissait des saucisses de consistance plus molle qui étaient cependant tout à fait acceptables.

Une étude préliminaire sur la préparation de mélanges de riz pré-cuit et de requin séchés au tambour a indiqué que la réalisation d'une boisson très acceptable, semblable aux boissons traditionnelles de préparation commerciale et domestique dans certaines régions Sud-Américaines est possible. Un stockage de courte durée à la température ambiante montre qu'il ne se produit aucun goût de poisson au taux de 20 pour cent de produit solide.

## Resumen

Los músculos de varias especies de pescado, magros y grasos, y almacenados en fresco y congelados, se han utilizado como sustituo parcial de la carne magra de vaca en productos de carne elaborados para el comercio, tales como salchichas de Frankfurt, rellenos de carne y embutidos de cerdo. La merluza (*Merluccius productus*) congelada y almacenada durante 12 meses se ha utilizado como sustituto de la carne en embutidos a niveles del 5, 10 y 15 por ciento del peso. Un equipo de pruebas experimentado no distinguiría entre estos embutidos y los que contienen sólo carne, cuando el pescado se incluye en una proporción no superior al 5 por ciento. En los productos comerciales derivados de combinaciones de pescado (*Sebastes* sp.), soja y pollos, o pescado solo, un equipo de exportos no podrá detectar, por el sabor, la sustitución de carne magra de vaca en concentraciones de hasta el 15 por ciento. El pescado produce un embutido más tierno que resulta muy aceptable.

El trabajo preliminar en la preparación de mezclas secas de merluza y arroz precocinados indican que es posible la producción de una bebida muy aceptable, similar a las tradicionales que se preparan de forma comercial o casera en algunos países de América del Sur. El almacenamiento a corto plazo a temperaturas ambientales

indica que no aparacen sabores de pescado. En preparaciones con un contenido de pescado a un nivel de un 20 por ciento del productos sólido, almacenados durante te un período corto de tiempo a temperatura ambiente, no se encontró sabor de pescado.

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## Introduction

Under utilized, unused and industrial species of fish are of low value because the technological problems in using them for food are formidable and their solutions more costly than is warranted by their return, at least in traditional forms. Under utilized pelagic species are generally small, oily, strong flavoured and dark fleshed. Demersal species tend to be lighter in colour, milder in flavour and lower in oil. They range in size from small to large but have no particularly desirable characteristics However, the nutritional value of these fish is as high as that of any of the more desirable food species. It is essential, therefore, that we learn how to make better use of these species for food at a cost that the consumer is able and willing to pay.

One approach is to recognize the magnitude of the technological and economic problems associated with making these species marketable in traditional forms and to consider them as a food commodity that requires relatively low-cost processing into forms suitable for use as ingredients in other foods. We are attempting to do this with wet, minced muscle, with drum-dried whole muscle and mixtures of dried muscle and cereals. The major use intended for these products is in processed meats but many other alternative uses suggest themselves.

The meat processing industry everywhere wants meat subsitutes that lower the cost of the product while retaining its characteristics. The amount of meat used in processed products in some countries is enormous (Table 1); significant reduction in its use can result in meaningful savings in grain that would otherwise be used for animal feeding. In countries where meat is less widely used, extension of meat products with otherwise unused fish may help to make the resultant products more widely available.

TABLE 1. *Processed meat products produced in the USA in 1973*

| *Product* | *lb x 10⁶* |
|---|---|
| Sausage (frankfurters, bologna, loaves) | 4,770 |
| Canned (luncheon meats, hash, chili, viennas) | 710 |
| Meat patties | 1,050 |
| Ground beef | 7,400 |
| *Total* | 13,930 |

Source: Anon., 1974

## Minced fish in sausage products

The minced flesh of many species of fish may be suitable for use as a meat extender in meat products such as patties and sausages. For these uses, the contribution of the fish towards improved nutritional value, good fat and water emulsification properties, and lower costs, are important factors. Fish flesh that is dark in colour can be used in some products without adversely affecting the appearance of the end product.

Several tests have been carried out with the muscle of fish commonly taken from the waters of the north-eastern Pacific (*Merluccius productus, Sebastes* spp. and *Theragra chalcogramma*) to determine how well they perform as partial replacers of the lean beef used as emulsifiers and nutritional protein sources in sausage products. This work has been done in co-operation with commercial sausage manufacturers and fish muscle has been found by these food processors to be eminently satisfactory in terms of function. Products made include frankfurters, bologna, pork sausage and luncheon meats. Texture, flavour, yield and resistance to spoilage have all been found to be satisfactory when 10% of the lean meat portion of the product was replaced by an equal weight of fish flesh.

A typical taste test of frankfurters, in which the lean beef is replaced at various levels with the muscle of Alaska pollock (*Theragra chalcogramma*), is shown in Table 2.

TABLE 2. *Flavour of frankfurters in which lean beef is replaced by Alaska pollock muscle at various levels*

| *Replacement level* | *Flavour score* |
|---|---|
| All beef | 4.2 |
| 5% pollock | 4.3 |
| All beef | 4.4 |
| 10% pollock | 4.2 |
| All beef | 4.3 |
| 15% pollock | 4.2 |

Meat patties or hamburgers are not only prepared at home but are also common items in school lunch programmes and in mass feeding institutions such as factory cafeterias. In 1973 more than one thousand million pounds of this product were consumed (Table 1). We have run several tests, in which minced fish muscle was added to meat patties, to determine the acceptability of such a product and have found the relatively mild flavour of meat patties requires a blander fish product than is needed for frankfurters. In a typical test we have replaced 10% of ground beef with an equal weight of minced Alaska pollock or 20% of ground beef with 10% minced pollock and 10% soy isolate. Most panelists found no difference in flavour or a slight reduction in beef flavour when pollock alone or pollock and soy protein replaced some of the beef. Differences in texture were not significant but some panelists indicated a preference for the experimental samples because they were considered to be more tender.

Ground beef, bought at the retail level, for making hamburgers usually contains up to 30% fat and ranges in price from slightly less than one dollar a pound to slightly more. A growing market has developed for soy isolate which is purchased by the consumer and is added to ground beef to stretch the product and help make it possible to live within the family food budget. Work now underway in Seattle suggests that a product of this type can be produced from drum-dried fish muscle.

## Fish processing and drying techniques

Pacific hake (*Merluccius productus*) was used for most of our experiments. Whole hake (fresh or previously frozen) was headed and gutted and the muscle recovered by mechanical deboning. Processing the separated muscle was easily accomplished by first mixing the minced flesh with 0.5% sodium chloride and 2% tripolyphosphate and then applying this mixture directly onto a drum dryer for about 20 seconds.

The surface temperature of the drum was approximately 150°C and drum spacing was 0.08 to 0.13 mm. The final moisture content of the product ranged from 5 to 8%. Drying problems were not serious provided the oil content of the fish did not exceed 2%. At higher levels, oil tended to separate in the dryer valley, yielding a product with a variable oil content and a gluey texture. The salt and sodium tripolyphosphate prevented the product from gaping and pulling away from the drum, which results in a non-uniformly dried product with a moisture content in excess of 10%.

With fresh fish, ideal drying conditions are not difficult to achieve and properly dried products have a lacy appearance. Hake that had been in frozen storage for more than three months was difficult to dry properly, even with the addition of salt and sodium tripolyphosphate.

## Properties of drum-dried whole fish muscle

Drum-dried hake muscle has a crumbly texture that makes it easy to mill to desired particle sizes. It is a relatively poor emulsifying agent but has excellent rehydration and water-holding properties. As shown in Table 3, dried whole hake will rehydrate with approximately four times its weight of water; heating the rehydrated mixture in boiling water for three minutes does not produce any free water. The rehydrated product has a chewy consistency; in contrast, rehydrated textured soy is characteristically mushy in the rehydrated form.

Flavour alteration during storage is a problem that has not yet been solved satisfactorily. At present, flavour stability is best when 200 ppm of tertiary butyl hydroquinone (TBHQ) and 500 ppm of ethylene diaminetetra-acetic acid (EDTA) (on a dry solids basis) are added to the wet slurry prior to drying. Samples of stabilized preparations have displayed no detectable rancidity during 60 days of storage at 20°C, but at 90 days the faint odour of fish is detectable. With hake containing less than 2% fat, the antioxidant properties of the TBHQ were enhanced if it was dissolved in commercially available hydrogenated oil carrier before it was added to the wet fish slurry.

TABLE 3. *Losses during cooking of beef patties extended with drum-dried fish muscle.*

| *Replacement in beef patty* | *Losses (%)* |
|---|---|
| Dried whole hake | 24 |
| 10% whole hake muscle | 20 |
| 7% whole hake muscle<br>3% wheat middlings | 20 |
| 20% whole hake muscle | 19 |
| 14% whole hake muscle<br>6% wheat middlings | 18 |
| 30% whole hake muscle | 16 |
| 21% whole hake muscle<br>9% wheat middlings | 18 |

## Washed fish muscle

Significant storage stability and colour improvement of the product can also be achieved if the minced flesh is extracted once with 0.1M sodium chloride prior to drying. The ratio of salt solution to fish is two parts to one. Extraction, which can reduce the yield by 20%, removes a large portion of the water-soluble sarcoplasmic proteins, non-protein nitrogen components, and some triglycerides and phospholipids. It has been demonstrated that these lower molecular weight compounds catalyse flavour alterations in dried fish protein preparations (Spinelli *et al.*, 1972). Although washing offers many advantages in terms of flavour and odour stability and colour improvement, we have chosen to put more effort into the development of drum dried whole muscle because of the lower costs involved and because of the better use that is made of the protein.

## Co-dried fish/cereal mixtures

Drying fish together with cereals offers a number of advantages. The addition of salt and sodium tripolyphosphate is not necessary to obtain uniform drying characteristics when the mixture contains more than 10% cereal before drying. Although most of our work with fish and cereal has been done with wheat middlings and whole-wheat flour at ratios of two parts fish to one part cereal, several other cereals have been tried and found to make satisfactory products.

The second advantage of mixing fish with cereal is the resultant cost reduction. When cereals are mixed with fish, the solids content of the mixture is increased above that of fish alone and the amount of water to be removed is reduced. On a unit weight basis, the costs of producing a fish/cereal combination are considerably lower than those for an all-fish product. The protein content of a dried mixture is lower than that of dried fish, of course, but a product with a final protein content of 60% is easily prepared and is superior, nutritionally, to vegetable proteins of comparable protein content.

Finally, mixtures of fish and meat permit improvement in the nutritional value of locally grown cereals and, conversely, extend the volume of fish. In these instances, the ratio of fish to cereal may be quite low. For example, the protein content of rice is approximately doubled by the addition of only 5% fish muscle. Mixtures of four parts rice to one part of fish have been prepared routinely in the laboratory and reconstituted into a sweetened and flavoured beverage (G. Luna, personal communication). This kind of mixture has great potential for a number of nutritious and pleasantly flavoured dry mixes for reconstitution at home and also for dry mixes for use in soups, stews and other "wet foods".

### Utilization of drum-dried fish proteins in meat replacement

Another use for fish muscle lies in the production of processed meats. In 1973, United States production of sausage products alone was nearly 5,000 million lb (Anon., 1974) and nearly 100 million lb (dry basis) of non-meat proteins were used simply to extend the product. It is estimated that by 1980 this figure will exceed 116 million lb (Stone, 1976). The effectiveness of rehydrated drum-dried fish muscle (three parts water to one part fish) in reducing cooking losses in meat patties is shown in Table 3. Losses are reduced significantly when the rehydrated product replaces beef at levels ranging from 10 to 30%. When fish muscle is dried with one-third its weight of wheat middlings and replaces beef at levels of 10 to 30%, similar reductions in cooking losses were experienced. With dried whole hake, fish flavour is not detectable at meat replacement levels up to 10%. Flavour tests have not yet been made with drum-dried, aqueous extracted fish.

Frankfurters or sausages have also been prepared with rehydrated drum-dried whole hake muscle. Triangle tests involving large taste panels indicate that the panelists cannot distinguish between all-beef sausages and those in which 10% of the beef has been replaced by dried hake muscle.

### References

**Anon.** (1974) *Livestock and meat statistics supplement for 1973.* US Department of Agriculture Economic Research Service, Statistical Reporting Service, and Agricultural Marketing Service, Statistical Bulletin 522. Washington DC: US Department of Agriculture.

**Spinelli, J., Koury, B. & Miller, R.** (1972) Approaches to the utilization of fish for the preparation of protein isolates. Isolation and properties of myofibrillar and sarcoplasmic fish proteins *J. Food Sci.*, **37**, 599–603.

**Stone, H.** (1976) Novel proteins – alternate food source *Food Prod. Dev.* February: **64**.

# Development of novel fish products in the Caribbean area

**L. Herborg**
Ministry of Fisheries, Denmark

## Summary

The paper deals with the development of marinated products and cooked/minced products from various fish species from the southern Caribbean.

The purpose of the work reported was twofold. First, to create marketing possibilities for glut landings of robins (*Carangidae*) and flying fish (*Exocoetidae*) by the production of marinated fish. Secondly, to commercialize under utilized fish species such as catfish (*Anarhichas* spp.), sharks and others, which appear as a by-catch in the bottom trawl fishery, by the production of fish sausages and burgers.

## Résumé

Cet article traite du développement des produits marinés et des produits hachés/cuisinés provenant de diverses espéces de poissons de la région Sud des Caraïbes.

Le but de l'étude présentée était double. Tout d'abord, créer des possibilités de marché pour les quantités excessives débarquées de poissons rouges (*Carangidae*) et de poissons volants (*Exocoetidae*) par la fabrication de poisson mariné. Ensuite, commercialiser les espèces de poisson sousutilisés tels que les poissons-chats (*Anarhichas* spp.) les requins et autres qui apparaissont comme des prises accessoires dans la pêche au chalut au fond, par la fabrication de croquettes de poisson ou d'hamburgers.

## Resumen

El artículo trata del desarrollo de productos adobados y productos picados y cocinados de varias especies de peces procedentes del Caribe.

El objetivo de este trabajo es doble. En primer lugar, crear posibilidades de comercialización para el exceso de pesca de alcotanas (*Carangidae*) y peces voladores (*Exocoetidae*), mediante la producción de pescado adobado. Y en segundo lugar, comercializar las especies poco aprovechadas como el siluro (*Anarhichas* spp.), el tiburón y otros, que aparecen como subproductos en la pesca de arrastre de fondo, para la producción de embutidos de pescado y hamburguesas.

## Introduction

The work mentioned in this paper was carried out in the southern Caribbean area in 1971. The purpose of the development work was to create marketing possibilities for glut landings of robins (*Carangidae*) and flying fish (*Exocoetidae*) caught around the Caribbean Islands as well as to commercialize under utilized fish species such as catfish (*Anarhichas* spp.), sharks and other fish species appearing in a bottom trawl fishery.

## Marinated fish

### *The marinating process*

The fish were washed and filleted, smaller pin bones being left in the fillet. They were then washed in clean water and transferred to a bath containing 7% acetic acid and 15% salt. This was stirred frequently for one to two hours to ensure good contact between fillet and brine and to open collapsed butterfly fillets or fillets which had stuck together meatside to meatside. This process is more easily carried out by mixing fillets and brine in a revolving cement blender for approximately 5 minutes, but it requires a fairly firm fillet to withstand this treatment. They were then transferred to a sealable container and covered completely with a brine containing 7% acetic acid and 15% salt, the proportion of fillets: brine being 2:1. At this stage the container was topped up completely with brine so that no air was left when the container was sealed; otherwise, a rapid oxidation of the small amount of fish oils separating in the process would take place on the surface of the brine. In practice this occurred within a week under tropical conditions.

During the experiment, the container was kept at 5°C for the first two days but this is probably not necessary if the brine and fillets are mixed thoroughly.

The containers were then stored at room temperature (25–33°C) in a sheltered place. During the first few days of processing the fillets became hard and tough but after two weeks they began to soften. After an initial drop of 25–30% the yield stayed constant, depending on the species, during the three months in which the experiment was followed. The initial loss was due to the dehydration effect of the acetic acid and salt, and occurred within the first few days. All control weighings were carried out after allowing the fillets to drain for 10 minutes. It was also observed that the fillets became slightly brownish with increase in time.

*The finishing process*

In the final process, the fillets were removed from the preservation bath, skinned and trimmed. The fillets were then rinsed in clean water and packed in containers of 'institution' size for hotels or in jars for retail sale. The brine used for the final packing was intended both to protect and to characterize the product and was made up to the following proportions:

| | |
|---|---|
| Water | 70 – 50% w/w |
| Sugar | 30 – 50% w/w |
| Acetic acid | 1.0 – 1.5% w/w |
| Spices | 0.5 – 5% w/w |
| Fillet: brine | 3:1 |

The products were now considered perishable and were kept cold. However, the shelf life at temperatures around 0–5°C was estimated to be several months. No experiments have been carried out on the keeping time at room temperature but it is estimated that it will not be more than a few weeks.

It should be noted that if raw onions or other spices heavily polluted with yeast and moulds are used, the high sugar content will lead to a rather fast growth of these micro-organisms, resulting in spoilage of the products.

The fillets should be completely covered by the brine to avoid rancidity. It might be of interest to know that the suspension of spices, some of which also act as colourings in the brine, will be stabilized by adding approximately 0.5% pectin.

*Case history*

*Robins:* The raw material was whole frozen robins. Fat content in the flesh was 1.8%. After thawing, the fish were filleted with a yield of 50% (unskilled operator). After washing, the fillets were immersed in a brine containing 7% acetic acid and 15% salt, placed in the refrigerator for two days and then removed to room temperature for further storage. The fillets were inspected regularly and yields, based on fresh fillets, were measured after 5, 7 and 90 days and are given below; the figures in brackets are yields based on whole fish.

| Days | 5 | 7 | 90 |
|---|---|---|---|
| Yield | 77% (38%) | 77% (38%) | 72% (36%) |

The fillets were skinned and trimmed before being placed in the 'cover' brine. The yield was 80% of the marinated (skin on) fillet giving a total yield of 0.50 x 0.75 x 0.80 = 30%, based on the whole fish.

The trimmed fillets were covered with a brine containing:

| | |
|---|---|
| Water | 57.5% |
| Sugar | 35.0% |
| Rum | 5.0% |
| Acetic acid | 1.5% |
| Allspice | 1.0% |
| Total | 100.0% |

The ratio of fillets: brine is 3:1. It is important that the fillets are completely covered by the brine.

The products were stored in the refrigerator for a week before consumption. Although the taste was a little too acid, the rum and allspice gave a pleasant flavour. The texture was very tough but equal to or even better than that of some of the imported herring products found in the region. It is believed that there might be a delicacy market among the hotels offering appetizers such as 'Rum Robins' or the like.

*Flying fish:* The raw material was whole frozen flying fish. Fat content in the flesh was 3.7%. After thawing, the fish were filleted in a specific way to remove the difficult side bones found in flying fish. The operation was a standard procedure and was carried out by a skilled operator. Yield was about 40%.

The fillets (butterfly type) were processed in the same way as robin fillets and they were inspected regularly. However, there was an air space in the container holding the marinades and the fish oil which floated to the surface went rancid in a very short time. Yields were measured after 7, 19, 30 and 90 days and are based on fresh fillets; figures in brackets are based on whole fish.

| Days | 7 | 19 | 30 | 90 |
|---|---|---|---|---|
| Yield | 70% (28%) | 70% (28%) | 68% (27%) | 70% (28%) |

Skinning the fillets was a little more difficult than with the robins since the meat seemed to fall apart to a higher degree. The meat was also whiter from the beginning and the development of a reddish brown colour was more accentuated. The yield after skinning and trimming was 70% of that of the marinated fillet, giving a total yield in the process of about 0.40 x 0.70 x 0.70 = 20%, based on the whole fish.

The skinned fillets were immersed in a 'cover' brine as described under robins and, generally speaking, displayed the same characteristics, ie a taste that was a little too acid, a good flavour and a tough texture. However, there might also, in this case, exist a speciality market in the hotel trade for appetizers such as 'Flying Fish Buccaneer'.

It has been shown that it is possible to preserve robins and flying fish by marinating them, for at least three months, at room temperature. It has also been observed that the fat content in the experimental material was too low to produce a product comparable to the classical marinated fatty fish *Clupea harengus.* However, seasonal variations in the fat content of the two fish species might remedy this.

It should be pointed out, as a social aspect, that 25 operators will be able to preserve 1000 – 2000 kg (2000–4000 lbs) raw materials per day by the suggested procedures; the throughput depending on labour skill, size and type of fish. If it is assumed that the price of the raw materials is 0.50 EC $*/kg, it can be calculated that the material costs and wages involved in the processing of eg 1,000 kg of flying fish will be about EC $ 750, giving a total of 200 kg of prepared fillets (flying fish) at a cost of EC $ 3.75/kg.

## Products based on minced fish meat

In the shrimp fishery on the banks of the Guyanas, considerable by-catches of catfish, 'whitings' and small elasmobranchs were often observed. However, there has been no marketing potential for these fish, which were dumped on the fishing ground. In the initial trawl fishery for demersal fish in the same area as for species such as sea trout (*Conoscyon virescens*), croaker (*Sciaendidae* spp.) and other marketable fish, the same by-catches, as mentioned above, were observed. The composition of the typical catch could be: sea trout 40%, croaker 10%, whiting 10%, with trash fish, including catfish of all sizes and smaller elasmobranchs, making up the remainder.

Since the market potential for trash fish in the region was very low, experimental work was carried out in co-operation with the Caribbean Industries Research Institute (CARIRI) in Trinidad.

### *Fish sausages*

It was decided to examine the possibilities of producing sausages from the meat of whiting, croaker and shark. An emulsion was prepared, the approximate recipe of which was as follows:

| | |
|---|---|
| Fish meat | 55–60% |
| Water | 23–25% |
| Fat | 12–15% |
| Wheat flour | 3% |
| Salt | 2% |
| Onion | 1% |
| Pepper | <1% |

The emulsion was prepared in a Hobart cutter (table model, with accessories). The raw materials for the production were skinned fillets of whiting, croaker and shark as well as coconut oil, pork fat and soybean oil. Wheat flour was used as a binder and onions and pepper as spices.

The ingredients were minced and mixed in the cutter until a stable emulsion was obtained. The mixture ('Fars') was stuffed into plastic casings, 6.5 cm. (2½") in diameter, and cooked for one and a half hours at 83–85°C. After cooling overnight, the sausages were scalded in boiling water for a minute to smooth the surface.

After allowing the sausages to bind for a day or two, they were examined. It was concluded that the above process could be used to obtain a sausage with an acceptable slicing texture; however, the texture was not as elastic as that from meat sausages. This might be due to a relatively poor emulsifying effect of the cutter when compared with specialized emulsifying equipment.

In the process, it was observed that the melting point of the fat was also important, giving a more 'dead' product if a higher melting point fat were used.

The final product was white and it was discussed whether the consumers would accept this when they were used to the reddish brown products based on meat. It should be possible to produce a sausage with a slightly coloured binder using fish meat as the basis and incorporating cubes of beef or pork meat; however, this was a problem to be solved in the further process. It was agreed that CARIRI should continue the experiments on the fish sausage production with some modifications.

Also, the production of fish sausages of the Vienna type was discussed. Basically, production would be along the same lines, although the texture of the final stuffing would be a little different to meet the specific characteristics of the Vienna sausage.

### *Fish burgers*

Since catfish have particularly red flesh it was tempting to try to produce fish burgers from this fish. The experiments were very limited but the following process was found to give an acceptable fish burger:

| | | |
|---|---|---|
| The binder: | catfish | 30% |
| | water | 10% |
| | salt | 1% |

was run for about 5 minutes in a cutter and then mixed with

| | |
|---|---|
| chopped catfish | 55% |
| onions | 4% |

and black pepper to taste.

The mixture was chopped for a couple of minutes and formed into pates, breaded and frozen. Oils could also be added to enhance palatability.

## Conclusion

The products mentioned in this publication should be taken as examples of the possibilities for making use of under utilized species. The experiments were carried out on a small scale during the author's stay only and contact with the project was lost when the author left the area.

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* 1 East Caribbean Dollar (EC $) = £0.21 at June 1976.

# Fish cheese: the preservation of minced fish by fermentation

**L. Herborg and S. Johansen**
Ministry of Fisheries, Denmark

## Summary

In many parts of the world including Denmark, large quantities of fish are not used for human food. At worst they are completely wasted and at best they are converted into animal foods. Many attempts have been made to utilize this fish, principally by fermentation techniques, but few attempts have been made to market such products although fermented fish products are common in SE Asia.

The fermentation technology involved in the production of cheese from milk seems to be transferable to fish and the paper describes attempts to make fish cheese. Minced fish flesh from a meat/bone separator is heated to 80°C for 20 minutes and, after cooking, whey powder or saccharose is added. A *Lactobacillus* starter culture is added prior to incubation at 30°C for 24 hours. After incubation the curd is pressed to remove water. The pressed blocks are then brined before being vacuum packed.

The product has a shelf life of several months at ambient temperature due to the low pH (4.5). This non-traditional method of fish preservation may have applications in a number of countries but some problems require investigation, for example the strong lactic acid taste of the product which is caused by the failure of the curd to ripen as in ordinary cheese.

## Résumé

Dans plusieurs parties du monde englobant le Danemark, de grandes quantités de poissons ne sont pas utilisées pour l'alimentation de l'homme. Au pire, elles sont totalement gaspillées et, au mieux, elles sont transformées en aliments pour animaux. Plusieurs essais ont été faits pour utiliser ce poisson, principalement par des techniques de fermentation, mais peu d'essais ont été réalisés pour commercialiser les produits obtenus, bien que ces produits à base de poisson fermenté soient courants en Asie du Sud-Est.

La technologie de la fermentation mise en jeu dans la production de fromage à partir de lait semble être transposable au poisson, et ce mémoire décrit des essais pour faire du fromage de poisson. La chair de poisson hachée, obtenue à partir d'un séparateur chair/arêtes, est chauffée à 80°C pendant 20 minutes et, après cuisson, on y ajoute de la poudre de petit lait ou du saccharose. Une culture starter de *Lactobacillus* est ajoutée avant l'incubation à 30°C pendant 24 heures. Après incubation, le caillé est pressuré pour éliminer l'eau. Les blocs pressés sont ensuite saumurés avant d'être empaquetés sous vide.

Le produit a une durée de conservation de plusieurs mois à température ambiante du fait de son faible pH (4,5). Cette méthode non traditionnelle de conservation du poisson peut avoir des applications dans plusieurs pays mais quelques problèmes demandent des études complémentaires, comme le fort goût d'acide lactique du produit. Celui-ci est dû au fait que le caillé n'arrive pas à maturité comme dans le fromage ordinaire.

## Resumen

En muchas partes del mundo, incluyendo Dinamarca, grandes cantidades de pescado no se utilizan para la alimentación humana. En el peor de los casos se desperdician por completo, y en el mejor se convierten en pienso para animales. Se han hecho nuevos intentos para utilizar este pescado, principalmente mediante técnicas de fermentación, pero, sin embargo, no se ha concedido suficiente atención a la comercialización de dichos productos, a pesar de que los productos de pescado fermentado son comunes en el sureste de Asia.

Parece posible que la tecnología utilizada en la fermentación del queso producido a partir de leche se transfiera al pescado, y el artículo describe los intentos que se han hecho para hacer queso de pescado. Se calienta a 80°C durante 20 minutos carne de pescado picado procedente de un separador carne-espina. Después de la cocción se añade polvo de suero o sacarosa. A continuación se añade un cultivo iniciador de *Lactobacillus*, procediéndose después a su incubación a 30°C durante 24 horas. Realizada la incubación, se prensa la cuajada para eliminar el agua. Los bloques prensados se tratan con salmuera antes de ser empaquetados al vacio.

El producto tiene una duración de almacenamiento de varios meses a temperatura ambiente, debido al bajo pH (4,5). Este método no tradicional de conservación de pescado puede tener aplicaciones en muchos países, pero hay algunos problemas que requieren ser investigados, como el fuerte sabor de ácido láctico del producto. Esto se debe a que la maduración de la cuajada no se logra perfectamente como en el caso del queso ordinario.

## Introduction

The numerous fermented fish products of SE Asia play an important role in the local food complex (Amano, 1962; Van Veen, 1965). Their manufacturing processes have been developed over long periods to suit the climatic conditions and specific market demands. The level of technology varies but all processes are based on the proteolytic action of enzymes originating either from the fish, from the developing microflora or from both.

Control of the fermentation is generally obtained by the addition of salt. The amount of salt added determines the time of fermentation, which might range from a few weeks to one year. In some varieties the development of a specific microflora is desired. In these cases carbohydrates are added and starter cultures might also be added. The resulting products are generally sauces or pastes.

In the North European countries, salted and spiced herring are examples of fermented products. The best example is probably the Swedish 'surstromming'. However, only a few such products are prepared.

Fish silage represents another group of fermented fish products. The proteolytic activities originate mainly from the fish guts; the preservation is effected by adding 2% of a mixture of formic and sulphuric acid. Fermentation experiments have also been carried out on fish silage. A mixture of minced, small pelagic fish and molasses was inoculated with *Streptobacterium plantarium* as the starter culture. However, for preservative reasons it was still necessary to add formic acid (Riemann, 1952, unpublished report, Danish Ministry of Fisheries).

Over the years, experiments have been continued on the fermentation of fish in order to obtain a product suitable for human consumption. Although some products of an acceptable quality have been found, no serious attempts have been made to market them.

## Definition of the present problem

The annual Danish catch amounts to 1,600,000 tons of fish. The majority of these fish are small pelagic species with no market potential for human consumption; 1,200,000 tons are used for fish meal and oil. Since the bulk of the fish is used for animal feed, there is a challenge to find new ways of utilizing this fish for human consumption. The present experiments which were carried out at the Fisheries Technological Laboratory, Danish Ministry of Fisheries, (Riemann, 1952, unpublished report; Johansen, 1975, unpublished report) should be viewed in this light. It should also be borne in mind that the technology developed could be transferred to other parts of the world.

## Experimental work

### *Background*

The fermentation technology involved in the production of cheese from milk seems to be transferable to fish. The preservative principle is a rapid increase of the lactic acid content which will prevent the growth of pathogenic bacteria and inhibit spoilers in the product. In the same process there will be a reduction of the sugar content. When the curd is formed, a concentration of protein and fat will take place during pressing. Later on the cheese will ripen due to the proteolytic and/or lipolytic activity of enzymes from the micro-organisms.

Minced fish meat of lean and fatty fish does not, however, closely resemble milk. The protein content is about five times greater, there is no sugar for the lactic acid fermentation and the fat content varies from nil to five times that of milk. The natural microflora in fish is also different from that of milk, both with respect to temperature optimum and substrate specificity. However, if the natural microflora and enzymes could be inactivated (eg by pasteurizing the minced fish) and sugar or other energy supplying substrates could be added, it would be possible to initiate a fermentation similar to the first steps of the cheese production. Pasteurization will coagulate the protein and the addition of rennin will not, therefore, be necessary.

### *The process*

1. The fish should be gutted in order to remove the gut enzymes (their initial proteolytic and lipolytic activities would adversely affect the final texture of the product). Also, the gut contents might reduce the acceptance of the products in some parts of the world.
2. The fish flesh should be separated from the skin and bones in a meat separator and preferably be strained to remove traces of bones and pieces of membranes and scales.
3. The minced fish flesh should be pasteurized. During this process the protein is coagulated and the natural microflora is reduced; this will facilitate the growth of the starter inoculum. Further, the enzymes present in the fish flesh will be inactivated and this will prevent liquifaction of the product during processing and storage; heating to 80°C for 20 minutes was

found to be sufficient. Rapid cooling to about 30°C should take place after pasteurizing.

4. Stirring gently, water (25%) and whey powder or saccharose (approximately 7.5%) are added; potassium nitrate and calcium chloride (0.02%) are also added.

   The water is added to ensure a uniform distribution of the other additives. Whey powder was originally used but this is not always available and saccharose has been shown to be suitable. The potassium nitrate will reduce the risk of butyric acid development during fermentation and the calcium chloride will improve the texture of the product.

5. The inoculation is made using either a freshly prepared starter culture or a portion of the previous day's freshly fermented production. The starter used is 0.5% of a propagated culture containing *Lactobacillus helveticus* and *Lactobacillus acidophilus.*

   The inoculated product is then incubated at 30°C for 24 hours. During, and at the end of this period the pH should be lower than 4.5. The incubation temperature will depend on the micro-organisms involved. For fatty fish, thought has been given to using other micro-organisms which will act on the unsaturated fatty acids of the fish oil but so far none has been found that is suitable.

6. After the incubation period the curd is pressed (in cheese presses) for a further 24 hours. The loss of press water will amount to 40–50% of the incubated weight and the press water will contain 20–25% of the dry matter. The pressed blocks are then held in a 20% salt brine for one and a half hours and packed under vacuum in polyethylene bags. Vacuum packing is necessary to avoid formation of mould on the surface, which is too porous to be washed daily with salt water (the usual procedure in the production of cheese).

7. The products will now have a stable shelf life of several months at ambient temperature. The reason for this stability is the low pH of the product (under 4.5 after 5 months) and probably the formation of antibiotics during the fermentation (Härnulu, 1970).

## Discussion

Several fish species are caught in huge quantities for the production of fish meal and oil. Most of these species, eg the sand eel (*Ammodytes* sp.) and Norway pout (*Trisopterus esmarkii*), have no market potential for human consumption at present. However, there might be non-traditional means of utilizing these species. The process described in this paper is one possible method.

The first problem to appear when discussing the utilization of small pelagic fish species is the demand for gutting since no technology has been developed, as yet, for this purpose. On the other hand, technology for the separation of meat from bones of whitefish or herring has been developed and the products have found a ready use.

Another problem is that the products resulting from the process in this early stage of development apparently do not ripen as ordinary cheese does but they remain as fresh curd. As a result the lactic acid taste is still very strong.

Products based on fatty fish will also have acceptability problems linked to the content of fish oil. It has already been shown experimentally that there is no development in peroxide values after five months' storage. This was not unexpected since the microflora has initially created an anaerobic environment. However, the peroxide value is not necessarily correlated with an undesirable change in the acceptability of the product.

## Conclusions

Minced fish flesh of lean and fatty fish can be preserved as a 'fish cheese' by lactic acid fermentation. The shelf life of the products will be several months at ambient temperature provided that they are vacuum packed in polyethylene bags.

## References

**Amano, K.** (1962) The influence of fermentation on the nutritive value of fish with special reference to fermented fish products of South-East Asia. In: *Fish in nutrition,* pp. 180–200. Surrey: Fishing News (Books).

**Härnulu, G.** (1970) Biologisk konservering of livsmedel. *Swedish Institute for Food Preservation Research, Report* No. 282.

**Van Veen, A. G.** (1965) Fermented and dried seafood products of South-East Asia. In: *Fish as food* (ed. G. Borgstrom), vol. III, 227–250. New York: Academic Press.

# Study on the utilization of *Engraulis anchoita* for the preparation of anchovies*

**S. Mattos A., E. Torrejon S. (FAO), L. Gus P. and J. Rodriguez S.**
Laboratorio Tecnologico del Uruguay, Uruguay

## Summary

*Engraulis anchoita* is one of the main potential resources in the south-western Atlantic. The possibility of processing this species as anchovies represents an important step towards its utilization for human consumption.

A description of the processing method is given, as well as variations in the total nitrogen, moisture, fat, non-protein nitrogen (NPN), total volatile bases (TVB), rancidity index (TBA), etc. The limit values of optimum maturation were established by determining the non-protein nitrogenous fraction. Those values above which filleting of the salted product becomes difficult were also indicated.

## Résumé

*Engraulis anchoita* constitue une des ressources potentielles les plus importantes de la partie sud-ouest de l'Atlantique. La possibilité d'utiliser cette espèce de poisson comme anchois représente un pas important vers son utilisation pour la consommation humaine.

Une description de la méthode de préparation est donnée ainsi que les variations de l'azote total, de l'humidité, des corps gras, de l'azote non protéique (NPN), des bases volatiles totales (TVB), de l'index de rancidité (TBA) etc. Les valeurs limites de maturation optimum ont été établies en déterminant la fraction azotée non protéique. Les valeurs au dessus desquelles le prélèvement de filets du produit salé devient difficile ont également été indiquées.

## Resumen

La *Engraulis anchoita* representa uno de los recursos potenciales más importantes en el Atlántico Sud-Occidental. La elaboración de esta especie bajo forma de anchoa significa una importante posibilidad de aprovechamiento de la misma para consumo humano.

En el documento se describe el método de fabricación utilizado, presentándose cuadros con las variaciones porcentuales en el tiempo de maduración de proteina, humedad, materia grasa, nitrógeno no protéico (NPN), bases volátiles totales (TVB), indice de rancidez (TBA), etc. Se fija el entorno que a criterio de los autores es considerado de óptima maduración sobre la base de la determinación de la fracción nitrogenada no protéica, asi como aquellos valores por sobre los cuales el fileteado del producto salado se torna dificultoso.

## Introduction

Anchoita is considered one of the most important pelagic resources of the South Atlantic Ocean. This study points out several technical considerations useful for the preparation of salted anchovy in Uruguay with a view to its utilization for human consumption.

## Raw Material

Anchoita inhabits south atlantic waters of the continental shelf, between 24°S and 47°S. The reproductive area is in the coastal waters of the Rio de la Plata basin, the feeding habitat is in the high sea region, and the winter habitat is in the northern region of the Argentinian continental shelf, along the Uruguayan coast to southern Brazil (Ehrhardt, personal communication).

During the first six months, size varies up to a maximum of 14 cm total length, increasing during the following six months to 18 cm. The relationship between weight and length is shown by the following equation:

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*A Spanish translation of this paper is available from the Tropical Products Institute.

$$P = 0{,}006446\ L^{3.02023}$$

where

$P$ = weight in grams
$L$ = length in centimetres

The chemical composition varies with the season. The highest fat level occurring between January and August (up to 18%). The average composition of anchoita for September is indicated in Table 1.

TABLE 1. *Chemical composition of anchoita (September)*

| *Moisture %* | *Protein %* *(N x 6.25)* | *Fat %* | *Ash %* |
|---|---|---|---|
| 72.2 | 16.9 | 6.9 | 3.5 |

Source: Laboratorio Tecnologico del Uruguay.

## Anchovy maturation

The preparation of anchovy is based on preservation by salt. The high salt concentration employed partially inhibits bacterial and enzymatic activity. Some of the salt tolerant micro-organisms and enzymes contribute towards the fermentative process of maturation of this type of product. In this connection, various investigations that were intended to demonstrate the exclusively enzymatic character of the anchovy process have taken place (Lepierre and Mercier-Marquez, 1951; Mercier-Marquez, 1959).

During processing a considerable part of the water in the fish is lost by the action of the salt; this depends on the species used, salt type, pressure applied etc. The non-protein nitrogen fraction in fresh anchovy is about 12%, much of this is lost to the brine by osmosis.

Depending on the extent of enzymatic activity various protein breakdown products are produced during the maturation process. Their measurement could well provide a method of assessing preservation conditions and the state of maturation; suitability for filleting may also be judged.

## Processing method

The trial followed normal industrial practice using 200 kg of fresh anchoita and plastic containers, 40 x 35 x 28 cm. The fish were beheaded and gutted manually, obtaining an average yield of 71%. Before putting into the containers, the fish were washed in a weak brine solution. A 5 mm layer of salt was put into the bottom of each container and alternate layers of fish and salt were put in; the layers of fish being at right angles to each other. A weighted wooden board was placed on the top layer of salt giving a pressure of approximately 40 g/cm$^2$.

On the third day the containers were topped up, the upper layer being removed and washed before repacking. The fish were constantly sprinkled with brine at 25°Bé; the overflow brine was re-used only during the first 24 hours when it was free of oil. Pressure on the containers was gradually increased up to a maximum of 100 g/cm$^2$. Maturation took place at room temperature, which varies seasonally between 11 and 33°C.

At the same time, experiments were carried out using 5 litre enamelled tin containers; similar results were obtained.

## Results

The chemical content of the salted anchoita was determined during the maturation period by the usual analytical methods (Okada *et al.*, 1972a). Part of the mature product was filleted, cut and canned with oil, the rest was kept in salt for further observations.

The results of the trial, shown in Table 2, are strongly influenced by the changes produced by pressing, sprinkling and the outside temperature.

Changes in the non-protein nitrogen (NPN) as a function of the maturation time are detailed in Table 3. Maxi-

TABLE 2. *Changes in the chemical content of anchoita during maturation**

| *Maturation time (days)* | *0* | *20* | *50* | *110* | *160* | *240* | *270* | *325* | *375* | *450* | *450*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Moisture % | 72.2 | 43.9 | 48.2 | 45.0 | 46.6 | 48.0 | 48.8 | 46.0 | 44.0 | 45.5 | 53.0 |
| Dry offal % | 27.8 | 56.1 | 51.8 | 55.0 | 53.4 | 52.09 | 51.2 | 54.0 | 56.0 | 54.5 | 47.0 |
| Total nitrogen % | 2.61 | 3.36 | 3.85 | 3.79 | 3.62 | 3.70 | 3.70 | 3.51 | 3.36 | 2.93 | 4.31 |
| Fat in dry offal % | 21.9 | 12.1 | 11.2 | 8.6 | 6.5 | 8.7 | 11.3 | 10.9 | 8.2 | 9.2 | 6.4 |

*Average values.
**Packed with oil after 240 days' maturation.

TABLE 3. *Variation of non-protein nitrogen content during maturation*

| *Days* | *0* | *20* | *50* | *110* | *160* | *240* | *270* | *450* | *450** |
|---|---|---|---|---|---|---|---|---|---|
| Non-protein nitrogen mg/100 g | 315 | 350 | 480 | 540 | 940 | 1,240 | 1,340 | 1,107 | 1,730 |
| Non-protein nitrogen as % total N | 12.1 | 10.4 | 12.5 | 14.2 | 26.0 | 33.5 | 36.2 | 37.8 | 40.1 |

*Packed with oil after 240 days' maturation.

TABLE 4. *Variation in trimethylamine nitrogen (TMA-N) and total volatile bases (TVB) during maturation*

| *Days* | *0* | *110* | *160* | *240* | *450* | *450** |
|---|---|---|---|---|---|---|
| TMA-N mg N/100 g | 0.55 | 8.6 | 11.4 | 12.5 | 11.9 | 12.6 |
| TVB mg N/100 g | 11.0 | 46 | 110 | 115 | 97 | 126 |
| TMA-N as % total N | 0.2 | 0.22 | 0.31 | 0.33 | 0.40 | 0.30 |
| TVB as % total N | 0.42 | 1.21 | 3.03 | 3.10 | 3.31 | 2.92 |

*Packed with oil after 240 days' maturation.

mum maturation is achieved after 240 days when the ratio NPN/TN reaches 33%. After 450 days the ratio increases to about 38% and the salted product has a good taste, odour, colour and texture (except in the ventral area which becomes very soft, rendering filleting difficult and, consequently, lowering the yield).

The volatile bases change slightly during the maturation process, as shown in Table 4. The figures obtained show that no abnormal bacterial increases have taken place, as confirmed by the bacterial counts of less than 1000/g after incubation at 35°C.

## Characteristics of final product

Anchovy fillets, in oil, were kept at room temperature (15 to 30°C) for seven months. No changes were found after this period, as confirmed by the TVB and TMA-N values (Okada *et al.*, 1972b) shown in Table 4. No special treatment was given to the oil and no additives were used.

1. Rancidity, as determined by the TBA method (Yu and Sinhuber, 1957), gave optical density readings of below 2.01 at 532 mm for every 5 g. The acceptance levels previously assessed were around 2.6.
2. The chloride content of the fillets was 16.7% and the pH 5.8.
3. The organoleptic properties indicate a good quality product with characteristic taste, a firm texture and pink-coloured meat.

We must point out that maturation and storing of the fillets in oil was made at room temperature and were therefore subject to Uruguayan seasonal changes.

## Conclusions

1. Normal temperature conditions in the country do not affect the maturation process.
2. Maturation can be regarded as complete when the ratio of NPN/TN in the muscle tissue has reached 33%; filleting is then easy and the yield is good.
3. After 380 days in the brine texture problems appear, especially in the ventral area, due to marked autolysis. At 450 days this problem is accentuated; the fish are difficult to handle and the filleting yield is decreased.

## References

**Lepierre, C. & Mercier-Marquez, J.** (1951) Studies on the production of anchovies at the Portuguese Institute for Fish Preservation. In: *Proc. Perm. Int. Comm. on Canned Foods, Paris,* 35, 1–6.

**Mercier-Marquez, J.** (1959) Le procédé industirel de l'anchoitage. In: *Proc. Perm. Int. Comm. on Canned Foods, Lisbon.*

**Okada, M., Hiras, S., Noguchi, E., Suzuki, T. & Yokoseki, M.** (1972a and b) *Utilization of marine products,* pp. 159–164 and 233–236, Japan: Overseas Technical Co-operation Agency.

**Yu, T. & Sinhuber, R. O.** (1957) II Thio-barbituric acid method for the measurement of rancidity in fishery products. *Food Technol.,* 11, 104–108.

# Acceptability testing of FPC Type B in selected developing areas

**Maria A. Tagle, S. Valand and D. G. James**
Department of Fisheries, FAO, Rome

## Summary

Good acceptance of FPC Type B has been obtained in several West African countries where the population is accustomed to eat fish. Where there is either a sociological avoidance of fish or no tradition of fish consumption, this product, which smells and tastes of fish, was rejected. The prospects of production and marketing of FPC Type B in the developing world are discussed in relation to pilot marketing studies.

## Résumé

On a obtenu que soit bien accepté le FPC de Type B dans plusieurs pays de l'Ouest de l'Afrique où la population est accoutumée à manger du poisson. Lorsqu'existe une réticence sociologique à la consommation de poisson, ou lorsque celui-ci n'est pas consommé de façon habituelle, ce produit, qui a le goût et l'odeur de poisson, a été refusé. Les possibilités de production et de commercialisation du FPC de Type B dans les pays en voie de développement sont discutés par rapport aux études pilotes de commercialisation.

## Resumen

En varios países de Africa Occidental, en los que la población está acostumbrada a comer pescado, se ha obtenido una buena aceptación de FPC (concentrado de proteínas de pescado) Tipo B. En los que hay una prevención sociológica respecto al pescado, o no es tradicional su consumo, este producto, que huele y sabe a pescado, ha sido rechazado. Se discuten las perspectivas de producción y comercialización de FPC Tipo B, en los países en vías de dessarrollo, en relación con estudios piloto de comercialización.

## Introduction

During the 1960's, there were intensive efforts to develop and introduce nutritions, low fat, powdered fish products which were high in protein and suitable for mass feeding to undernourished populations in the developing world. Unfortunately, the abandonment of expensive pilot plant and industrial trials in the United States, Canada and elsewhere indicate that, although the technology is now well known, there is little chance of successful introduction because costs are escalating and also for a variety of other reasons. This view is supported by the fact that, at the time of writing, no factory is making fish protein concentrate Type A (FPC Type A),* the product which has been the subject of most investigation. Stocks of FPC Type A are available as international food aid and have proved most useful when mixed with cereals to improve the biological value of the protein for human nutrition (Rostad, 1975). Swedish production may continue when present stocks are exhausted.

In the face of the well-documented need for increased flow of protein to vulnerable groups and the need to establish nutrition policies in low-income countries (Dessau, 1965; Aylward and Jul, 1975), a re-evaluation of the possible role of powdered fish products in human nutrition is urgently required. It may well be that a product which smells and tastes of fish (FPC Type B) would have more appeal to unsophisticated people in developing countries than the colourless, flavourless and odourless Type A. The main difference between the two products is that the Type A has the fat removed while the Type B contains up to 10% fat. The Type B product may also be more satisfactory nutritionally, as extraction of the fat not only removes the flavour and odour but also lowers the energy value and removes fat soluble vitamins and some minerals. It is well known that the lower socio-economic groups in a population, ie the people who require nutritional assistance, are the most resistant to change in their food habits. People who consume dried fish, as part of the traditional diet, may be prepared to accept FPC Type B, with a similar odour and flavour, as a substitute.

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* FPC Types A and B are described and defined in PAG Guideline No. 9 (1971).

In Norway, where suitable resources exist, there has been sustained interest in the production of FPC Type B to be made available as international assistance to developing countries through such organizations as the United Nations World Food Programme (WFP). Since 1969, considerable quantities of Norse Fish Powder, as the product is known, have been produced in Norway and donated to needy countries mainly by charitable organizations. Earlier this year, 1500 tons were supplied to Bangladesh by NORAD, the Norwegian International Aid Agency, and a further 1500 tons will be delivered in October 1976.

This paper gives some early results of acceptability studies which have been carried out in the developing world by an FAO project sponsored by NORAD. The purpose of the project was to provide information to advise the WFP on the conditions under which fish powder could be included in the 'food basket' (provided as aid to selected developing countries). In addition, the prospects of marketing rather than donating the product were investigated. Limited studies were also carried out on the feasibility of producing fish powder in developing countries.

## Background

It is not necessary to review, in detail, the history of powdered fish products in human nutrition, as the efforts during the 1960's have resulted in a proliferation of literature on the subject. Major conferences (Kinloch, 1968; Tannenbaum *et al.*, 1974), reviews (Finch, 1970; Halliday and Disney, 1971) and bibliographies (Library of Congress, 1970) not only give the history of recent developments but, to a large extent, identify the reasons for failure. However, a brief reflection may be valuable to establish the background and indicate that the FAO/NORAD project has a sound base.

Dried fish has, from time immemorial, been a most important item of the diet. Reduction to a powder, for ease of use or storage, is only an extension of this process and is by no means a new idea. Pariser (1968) quotes a diary of Arrian, written in 325 BC, which describes the pounding of dried fish to a flour and then incorporating it into bread; this was observed on the eastern shore of the Arabian Gulf. Dreosti (1974) mentions the first modern production and incorporation of FPC as a dietary supplement in South Africa in 1937. Considerable quantities of this product, made by extracting fish meal with hot ethanol, were used up until the late 1950's. The major part of subsequent work has been on solvent extraction processes designed to produce FPC Type A. The USA and Canadian experiments concentrated on extraction of fish with iso-propyl alcohol; both the process and the product suffered from inherent difficulties. The failure of these projects is probably responsible for the low status of powdered fish products, which is perhaps unjustified. Sharply rising costs, and unforeseen difficulties in recovery of the solvent when the process was upgraded from pilot to industrial scale, were exacerbated by artificial restraints imposed by the US authorities (Olcott, 1974). An inherent problem with powdered fish products is the gritty and sandy texture.

This, coupled with flavour reversion of Type A on storage, made incorporation as an 'invisible' protein supplement extremely difficult.

Attempts to overcome these deficiencies led to the development of fish protein isolates with functional properties but the rapidly escalating costs, shown by Spinelli *et al.* (1974), put these completely out of the reach of developing countries. Uses will no doubt be found for their excellent emulsion forming properties by sophisticated food manufacturing industries such as in Poland (Anon., 1976). However, even in the developed world, the shortage of fish and the expense of preparation will probably restrict the use of fish as a protein extender. A further problem with the US approach was the concept of using powdered fish products to fortify the American diet, which is already regarded by many as being too rich in protein. Sufficient recognition was not taken of the different eating habits of needy and vulnerable groups in the developing world. Also, as Bligh *et al.* (1974) point out, fish were cheap and abundant in North America when the experiments started but today prices have risen and there are periods of scarcity.

It is interesting to speculate why so much effort was devoted to solvent extraction processes while little attention was paid to preparation and introduction of unextracted products. Dreosti (1974), commenting that in the future the unextracted products are likely to be used by undernourished people, said: 'It is amazing to see hundreds of publications on extracted FPC and only isolated publications on unextracted FPC . . .' Many other authors, including Lovern (1969) and Halliday and Disney (1971), have suggested that a less sophisticated product, which smells and tastes of fish, may be of more value in the developing world.

However, concerted international efforts were not made until the Norwegian production of Norse Fish Powder started. At present, the product is moving ahead slowly but there are still many unanswered questions on criteria for acceptability and whether large-scale production in the developing world is possible.

The product and its method of production are described by Norsildmel (1974); further aspects of the equipment and marketing prospects are given in an FAO report (1975) and it will suffice here to say that all production is from fish that have been chilled when caught and handled as human food. Close attention is paid to sanitary control and the proximate composition is 70–75% protein, 10% fat (maximum), 10–15% ash and 10% moisture (maximum). Both mackerel and capelin have been used as raw material.

Approximately 4000 tons of fish powder have been produced and supplied to a number of developing countries, mostly for relief feeding. Limited acceptability tests have also been carried out in other countries. In almost all cases, the degree of acceptance has been high although it must be recognized that acceptance may be conditioned by the fact that, in many instances, the product has been supplied in times of extreme food scarcity such as famine and disaster.

## The FAO/NORAD project

The objectives of the FAO/NORAD Project [TF INT 120 (Nor)] are:

(a) To conduct acceptability testing of fish powder in West Africa and Indonesia in order to evaluate the suitability of the product for inclusion in WFP food-aid programmes.

(b) To undertake a market study in order to evaluate the commercial potential of the product.

(c) To carry out a feasibility study on the prospects of production in West Africa.

The project started in September 1974 with the appointment of a nutritionist team leader, who was joined by the marketing expert in November. Assistance has also been provided by associate expert nutritionists funded by Sweden and Norway. During 1975, the services of a consultant sociologist were available for three months and a processing consultant, for feasibility studies, was also employed for a similar period. At all times, close contact has been maintained with the FAO Nutrition Division and the WFP. The team has received technical and administrative support from the FAO Department of Fisheries. Contacts have also been maintained with other projects on the testing of fish powder in Bangladesh and India. In Bangladesh, fish powder is being used for relief feeding and, in India, for nutritional studies at the Medical College, Trivandrum (Menon, 1976).

The countries, which were selected for testing in West Africa, were Liberia, Senegal, Mali and Niger; these are two coastal and two land-locked countries in the same region. To ensure continuous supervision and to overcome local language problems and cultural differences, the greatest possible use was made of local staff to introduce, monitor and control the tests. In all cases, the tests were co-ordinated with existing WFP food-aid programmes.

## Methods of acceptability testing

The traditional diet, in the countries where tests were carried out, consists of boiled cereal covered with a sauce or soup. It is, therefore, possible to introduce fish powder as a condiment to be mixed into the sauce since comparatively small quantities of fish powder are needed to provide a high quality protein supplement to that of the staple diet.

In West Africa, the institutions selected for tests were eight secondary schools in Liberia, six rural primary schools in Senegal, five hospitals in Mali and six schools in Niger. Selection was made with the intention of having a geographically representative coverage of the countries. In Indonesia, tests were started in January 1976 through a 'food for work' project in Central and Eastern Java. Most of the results quoted in this paper are from West Africa as only preliminary indications are available from Indonesia.

The instructions given to those preparing food were to use one packet of 200 g for each 15 portions. This would give about 13 g of fish powder per person per meal. (The product was delivered in 200 g aluminium/paper/PVDC laminated pouches packed in fibreboard cartons.) The fish powder was to be included in one meal on alternate days.

Tests were carried out over a period of five to six months and every attempt was made to collect the following information in each location:

(a) Average individual consumption, by weighing the total food prepared, subtracting the left-overs and dividing by the number of consumers.

(b) A visual estimate of consumption, by recording the percentage of meals which were offered and fully consumed.

(c) Asking questions of those preparing and consuming the food.

(d) In one location where meals were on sale, the relationship of the total number of meals prepared to those remaining on days with and without fish powder was recorded.

It was necessary to take this simplistic approach to acceptability testing as it was not possible, under the difficult local conditions, to standardize procedures for 'plate-waste' trials. The local staff controlled the tests as an additional duty and they could not be expected to perform comprehensive trials. In addition, in many schools where 4 to 12 children ate from a common pot, individual observation was not possible and records were kept on a number of selected bowls.

The underlying assumption of the acceptability testing was that, if the average food consumption on days when fish powder was used was equal to or higher than on days when it was not used, then the product was acceptable. It should be pointed out that there was no intention of carrying out a nutritional study. An important part of the work was carried out in rural surroundings, under extreme difficulties, and feeding supplements only two or three times a week could not be expected to give measurable results. It was also not possible, except in the hospital tests, to obtain information on the rest of the diet.

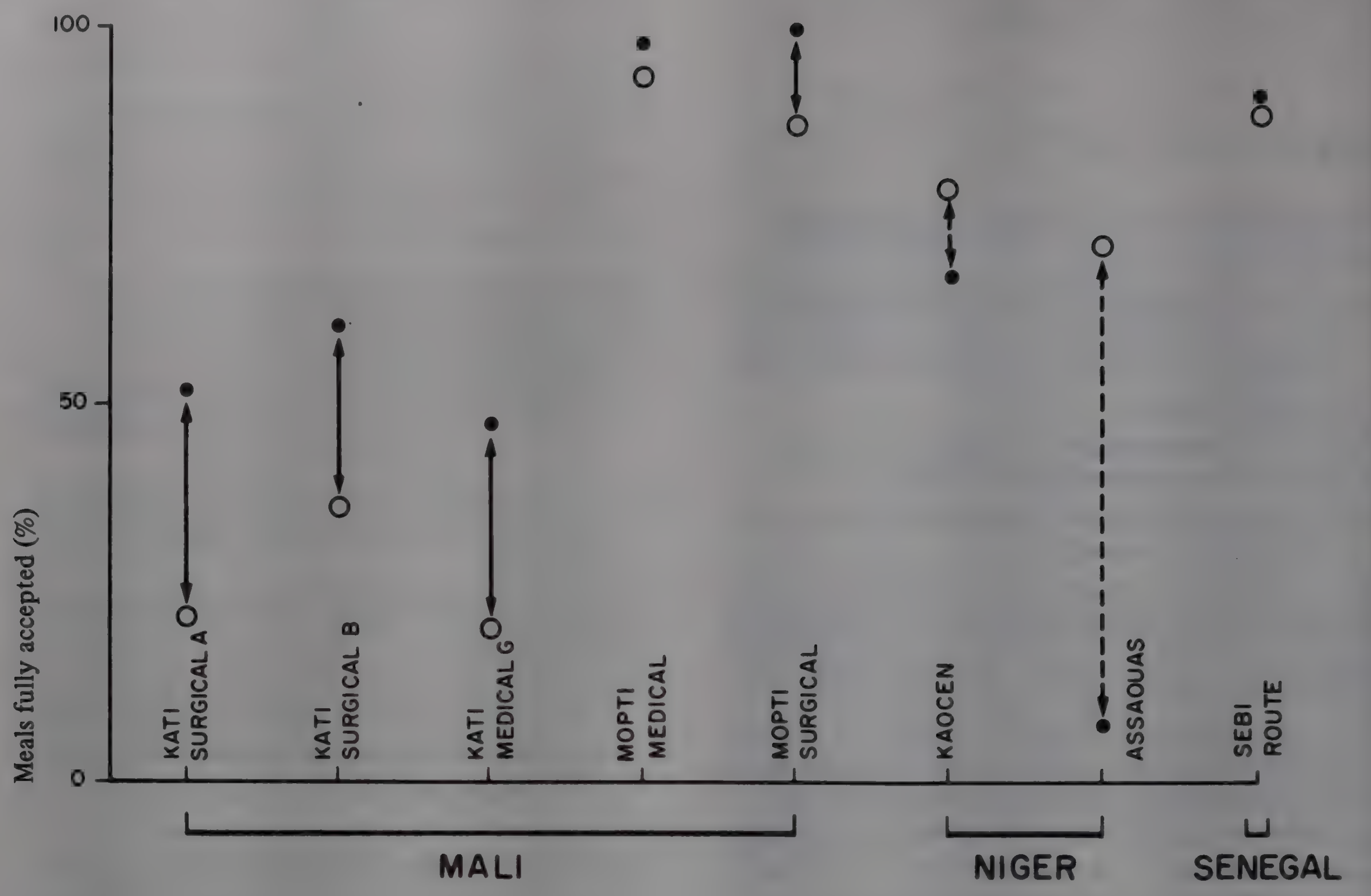
## Results of acceptability tests

A statistical analysis of the available data was carried out and results are summarized in Figures 1 and 2. Significant differences mentioned in the text are all at the 5 per cent level ($p < 0.05$).

### *Liberia*

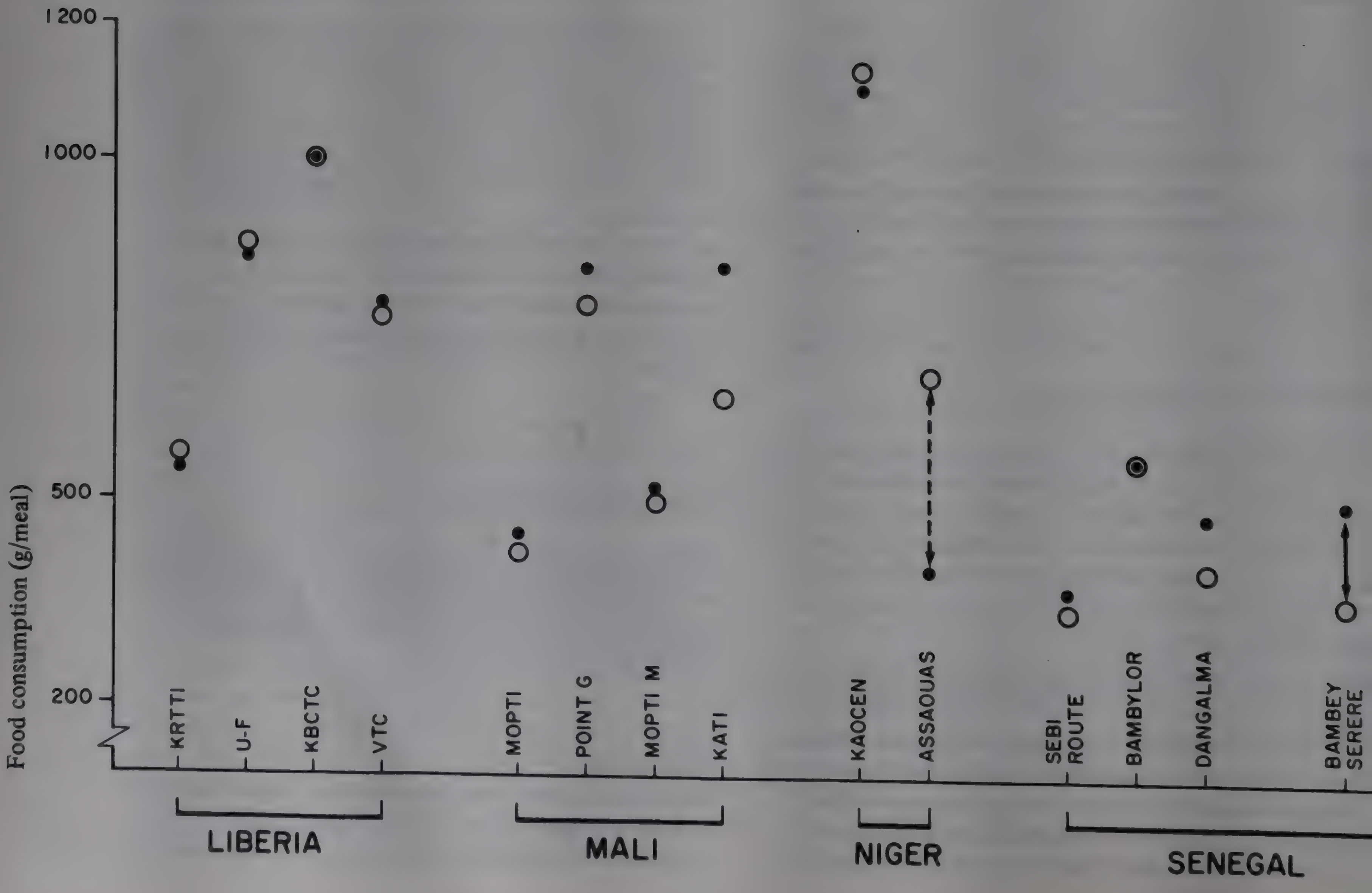
Tests were carried out in eight secondary schools in four geographic regions of the country. About 2000 consumers were involved for the period between March

**Figure 1**
**Percentage of meals fully accepted**



Key
● With fish powder.
○ Without fish powder.
⟷ Significantly higher.
⇠ ⇢ Significantly lower.

**Figure 2**
**Estimated average food consumption per meal**



and August 1975. One of the schools did not complete the testing but results are available for the other seven.

In four schools, average daily consumption was measured for between 272 and 338 pupils; consumption was similar on days with and without fish powder. In one other school, where a total of 325 pupils were involved, an indirect estimation of consumption was made by weighing the left-overs; the quantity prepared each day was almost constant but the mean daily weight of left-overs was less on days when fish powder was used. In three of the schools, a measurement was made of the average proportion of portions fully accepted compared with those distributed; results were similar with or without fish powder. In two further schools, observation was kept on meals offered for sale; the number of meals sold was compared with the number prepared. When total sales on days when fish powder was included were compared with those on days when it was not, the results were similar; in either case, there were very few meals unsold. In this case, the number of consumers was between 370 and 1100.

An important feature of these tests was that in six out of the seven schools there was a considerable reduction in the amount of fish powder included per person. Presumably for organoleptic reasons the level was reduced to 50 per cent of what was recommended and, with some recipies, to as low as between 2.5 and 3 g per person.

### *Senegal*

The acceptability tests were conducted in six rural primary schools in three different regions between February and June 1975. The average individual consumption was recorded in five schools; in one, this was significantly higher when fish powder was included, while, in the other four, there were no significant differences. The average number of portions fully accepted to those prepared was recorded in only one school and the results were similar with or without fish powder. The tests were discontinued in the other schools as there were never any left-overs. Observations in one school showed no indication of 'fish taste fatigue' as individual consumption figures were comparable for the whole period. The quantity per meal was not decreased in any school and ranged from 12 to 15 g per pupil per lunch.

### *Mali*

Acceptability was tested in five hospitals in three different regions between February and August 1975. The patients involved were generally chronic medical or surgical cases. Average individual consumption in four wards of three hospitals, involving 162 to 237 patients, was not significantly different with or without fish powder. In four out of five wards in the same hospitals, the average proportion of portions fully accepted to those distributed was significantly higher when fish powder was included; in the other ward, the acceptance was similar. Consumption of fish powder per person per meal ranged from 10 to 17 g, except in one ward where a level of up to 23 g was used. There was some indication of 'fish taste fatigue' which may be associated with the fact that, in two regions, fish is cheap and is frequently used in hospital meals; as a result, some chronic patients had fish for almost every meal.

### *Niger*

In order to give a better geographical coverage, tests were carried out through two WFP programmes in nomadic primary and secondary schools. Six institutions and 1200 potential consumers, whose ages ranged from 6 to 22 years, were involved. The results in Niger are confusing but show a complete reversal of the trend in the other countries. In two secondary schools for girls in Niamey, there was immediate rejection. At the same time, the Niamey secondary school for boys showed no immediate difficulties. During the first week, there were indications of higher consumption when fish powder was included. However, after approximately one month there was a total rejection, forcing cancellation of the tests.

In the first of the two nomadic primary schools, the tests were stopped after one month on the decision of the headmaster since there was strong evidence of dislike and rejection. In the other school, the headmaster continued the tests although the tendency to aversion did not diminish and both the food consumption and percentage of meals fully accepted was significantly lower when fish powder was added.

The final tests in a teachers' training school, Kaocen, in Tahoua were continued for the full period of six months. Both the headmaster and the bursar at the school energetically supported the tests and had a positive attitude towards them. There was an indication that the quantity per serving was reduced for preference; it is also evident that, with the incredible average consumption of over 1 kg of food per person per meal, the concentration would have been much reduced. It is obvious that the results from Niger require some qualification and explanation; this is offered in the general discussion on the acceptability tests below.

### *Indonesia*

It is too early to quantify the results from Indonesia, where tests started very recently. Preliminary indications are that the product may be acceptable but consumption per meal is likely to be considerably reduced from the recommended level. Results for Indonesia will be reported later but will not be strictly comparable as different methods are required due to the nature of the food-aid programme.

## Discussion on acceptability tests

It was not possible to obtain full results in any of the four West African countries. In each case, some institutions did not complete the testing or results were incomplete for some indicators of acceptability. However, the results available tend to confirm the hypothesis that fish powder is an acceptable protein supplement for people who enjoy dried, salted or smoked fish as part of their traditional diet. In areas where fish is not eaten, and more particularly where there are taboos associated with fish, acceptance is likely to be very limited.

In Liberia, Senegal and Mali, the test populations generally have a high consumption of fish (dried or fresh). It is eaten up to five times per week in Liberian schools, once or twice in some schools in Senegal and frequently in the hospitals in Mali.

In Niger, the consumption of fish varies considerably among different regions and depends on socio-economic circumstances. A sociological study was initiated to examine the disturbing results from Niger and it is preferable to discuss the conclusions regionally.

The three schools in Niamey, the capital, drew their pupils from the highest socio-economic strata. It is probable that their rejection was based on the fact that fish powder had recently been used for relief feeding of refugees during the devastating drought (League of Red Cross Societies, 1974). As a result, the image of the product was tarnished by its association with low economic status and destitution.

There are more complex circumstances surrounding the rejection by the nomadic primary schools. The population follows their herds of cattle and camels and eats mostly milk, millet, sorghum and occasionally meat; they do not eat fish and, in fact, some tribes avoid it. The catfish, for instance, has a totemic significance and, thus, a taboo on consumption; there was suspicion that catfish had been included in the fish powder. It also appears that in some areas of Niger, there is a symbolic aversion to fish as being food for slaves.

These comments identify the problem of assessing, in advance, whether fish powder is acceptable to a specific group. It is not clear whether the only partly successful test in Niger was a genuine preference or was due to the enthusiasm of the staff.

From the nutritional point of view, it may be very significant that there are indications of a tendency to reduce the quantity per meal for organoleptic reasons. As the level of inclusion (13 g per head) is a relatively small amount, a substantial reduction could result in ineffective attempts to supply protein needs.

### The concept of marketing

It was considered that marketing prospects should be investigated to determine the commercial future of the product. Successful market opportunities are particularly necessary if production is to be transferred to the developing world. Marketing studies were concentrated on West Africa with one attempt in Indonesia. A start was made with a general survey of available markets to determine the necessary approach; with this as a basis, test sales were conducted to obtain more precise information on packaging alternatives, obtainable prices and quantitative market potential which are essential elements in a feasibility study for production.

A market development effort has existed for about four years in Nigeria and has started in two additional countries, Liberia and Ghana, which were chosen for test sales. All three countries have expanding cash economies but have substantial urban and semi-urban poor sectors of the population; it was felt that the product could have an appeal to these groups. It was decided, at the outset, to market the fish powder as a condiment with a fish odour and flavour since dried and smoked fish are widely used as condiments in these countries.

The following considerations were taken into account: packaging, distribution, sales force requirements, promotion and advertising, and price.

The objectives of packaging should be:

(a) To provide good protection from infestation and contamination.

(b) To be attractive.

(c) To maintain a low unit price to keep the product within the purchasing power of the target groups.

(d) To maintain a low price per kilogram.

As these objectives are in conflict with each other a compromise has to be reached between pack size, price and type of packing material. The only way to obtain more precise information on consumer preferences was to try out various combinations. For this purpose it was decided to try two types of 75 g packs ('plain' and 'exclusve') with one type of 200 g and one of 25 g (both 'plain'); these were in addition to a 50 g pack used in Nigeria.

The distribution channel, which is regarded as the most important, is the urban popular market. These markets are controlled by mammies who act as retailers or as wholesalers who supply a variety of products to retailers. The effort was concentrated on the mammies who handle packaged dry goods such as soup cubes, canned sardines and mackerel, biscuits, soap, detergents etc; fish powder falls into the same range of products. The main secondary distribution channels are supermarkets and institutions.

The sales force required for selling and promotion has to be on good terms with, and recognized by, the mammies. Distribution agreements were made with a local company handling food products.

Promotional efforts in the popular markets concentrate on special offers of the 'thirteen to a dozen' type. Display material and demonstrations can also be used in some areas. Radio advertising is regarded as the most suitable way of reaching the target groups.

With regard to pricing, a trade margin of approximately 50–60% on import or ex-factory cost is considered adequate in West Africa to cover the mark-ups of importer/trading company, wholesaler and retailer, as well as providing for promotional expenditure of approximately 10%. Sales and other taxes would be additional. Assuming that local manufacturing costs would be of the same magnitude as imports from Europe, this should give the following selling price calculations (Table 1) for different packs and pack sizes excluding sales taxes and customs duty.

### Results of test sales

A brief country by country survey of progress is given below.

TABLE 1. *Selling price calculations for different packs (US$/kg)*

| *Type of pack* | *75 g 'Exclusive'* | *75 g 'Plain'* | *200 g 'Plain'* | *25 kg Bag* |
|---|---|---|---|---|
| Landed cost CIF/assumed production cost per kg | 1.92 | 1.72 | 1.35 | 0.82 |
| 50% mark-up | 0.96 | 0.86 | 0.63 | 0.41 |
| Total | 2.88 | 2.58 | 1.98 | 1.23 |
| Total per pack | 0.21 | 0.19 | 0.40 | 30.75 |
| Total rounded upwards to recommended retail price | 0.25 | 0.20 | 0.40 | 30.75 |

*Nigeria*

Fish powder has been on sale in Nigeria since 1971 in an aluminium/polyethylene laminated pouch of 50 g. The retail price has been 10 kobo* (approximately US$ 0.17). The price to the consumer is, therefore, about US$ 3800/ton compared with canned sardines at US$ 4000/ton. The import price for Norwegian stockfish CIF Nigeria is US$ 3500/ton but the price to the consumer exceeds US$ 9000/ton. Although the sales force is efficient, there has been little advertising or promotional effort. The present level of sales is about 200 tons per year; the rate of growth is demonstrated by Table 2 for the seven months from November 1974.

TABLE 2. *Sales from November 1974 to May 1975*

| *Month* | *Nov* | *Dec* | *Jan* | *Feb* | *Mar* | *Apr* | *May* |
|---|---|---|---|---|---|---|---|
| Sales in cartons of 288 pouches | 76 | 169 | 191 | 238 | 324 | 472 | 870 |

The product competes as a condiment with imported stockfish, locally produced dried fish, and meat and soup cubes; if it can be established on the market on equal footing with these products, the market potential should be considerable.

*Ghana*

The first consignment of fish powder, amounting to about three tons, was sold within days of the start of test sales. Only four locations, representing less than 10% of the population, were chosen. Promotional efforts were limited to posters and the free distribution of some samples. The trade cleared its stock in about two weeks and, without exception, wanted to buy more. All social strata were represented among the consumers but the product moved fastest in the mass market. The most popular pack size was the 75 g.

*Liberia*

Approximately 200 kg were sold, during a period of three months, in locations representing about 75% of the market. The effort was significantly smaller than in Ghana; it consisted of limited distribution of samples and posters and was mostly directed towards supermarkets and fish shops. The most popular pack size was 75 g. It should be noted that most consumers in Monrovia, who tried the product, reportedly bought it again.

*Indonesia*

After panel and storage tests in Indonesia, it became apparent that product and packaging modifications will be necessary before the products can be put on the market.

## Conclusions from test sales

Results from the tests indicate that it is possible to develop a commercial market for fish powder in West African countries which have an expanding cash economy. However, the build-up to substantial quantities will require time and systematic promotional efforts.

## Feasibility of production in developing countries

The preparation of a feasibility study for production in Senegal is under way and it appears most likely that, under favourable circumstances, it would be possible to manufacture fish powder in that country.

## Other considerations

The most serious problem encountered during the project was the vulnerability of the product to infestation by insects and attack by rats; acceptability tests in West Africa and Indonesia all suffered from these problems. There were no reported difficulties with the market trade, probably due to the superior packaging material: an aluminium/polyethylene laminate was used for the 75 g packs, which made up most of the consignments. In well-controlled central storage, the product for acceptability trials did not suffer. However, it was extremely difficult to prevent infestation, by dermestid and bostrycid beetles, and attack by rats in uncontrolled stores at the consumer end. It is obvious that, with the conditions encountered in the tropics, vastly improved packaging materials are required; inevitably this increases the cost of the product. Dreosti (personal communication) considers that the only truly effective way of preventing infestation is to use tin-plate containers with gas packing to reduce oxidative changes. At present, tests are being carried out with a number of different packaging materials, in Bangladesh and elsewhere, as it is considered imperative to solve this problem to achieve a breakthrough with the product.

## General conclusions

The results of the project to date indicate that, with certain reservations, fish powder is an acceptable supplement to the diet and markets can be established for the product. However, there are still many unanswered questions and work will continue in other developing countries. It should certainly not be assumed that fish powder is universally accepted by the needy or even by people who eat dried fish. In each case, an evaluation must be made of the traditional diet, cultural practices and social conditions. In many instances, acceptability tests will be required before general introduction. This type of testing may be complicated by relief feeding in disaster areas, a purpose for which the product is ideally suited because it has a high protein content and good storage ability if it is properly packed. It will be a long time before all these questions are fully answered and production can be established in the developing world.

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* 1 kobo = US$ 0.017

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### References

**Anon.** (1976) Polish protein from fish meat. *Pol Marit. News.* January, 17–19.

**Aylward, F. & Jul, M.** (1975) *Protein and nutrition policy in low-income countries.* London: Charles Knight, 150 pp.

**Bligh, E. G., Dyer, W. J., Regier, L. W., Dingle, J. R. & Legendre, R.** (1974) Functional and nutritive food proteins from fish. In: *Fishery products* (ed. R. Kreuzer), pp. 290–291. Surrey: Fishing News (Books), 462 pp.

**Dessau, J.** (1965) The role of multilateral food aid programmes. *World Food Program. Stud.* No. 5. Rome: FAO, 35 pp.

**Dreosti, G. M.** (1974) The future of powdered fish products. In: *Fishery products* (ed. R. Kreuzer), pp. 100–106. Surrey: Fishing News (Books), 462 pp.

**FAO** (1975) Expanding the utilization of marine fishery resources for human comsumption. *FAO Fish. Rep.* No. 175, pp. 27–31,

**Finch, R. A.** (1970) Fish proteins for human foods. *Crit. Rev. Food Technol.,* **1**, 519–580.

**Halliday, D. & Disney, J. G.** (1971) Fish protein concentrate, a review. *Rep. Trop. Prod. Inst.* No. G58, 18 pp.

**Kinloch, J.**, ed. (1968) Proceedings of a Conference on fish protein concentrate. *Can. Fish. Rep.* No. 10. Ottawa: Department of Fisheries, 166 pp.

**League of Red Cross Societies.** (1974) Joint programme for medical and nutritional assistance to the drought affected population, Niger Republic. Geneva: League of Red Cross Societies.

**Lovern, J. A.** (1969) Problems in the development of fish protein concentrates. *Proc. Nutr. Soc.*, **28** (1), 81–85.

**Library of Congress.** (1970) Fish protein concentrates: a comprehensive bibliography. Washington, DC: Library of Congress, catalogue card No. 79 606672.

**Menon, M. D.** (1976) Greater emphasis on old concepts needed. *Seaford Export. J.*, **8** (1), 21–26.

**Norsildeml.** (1974) *Norse fish powder.* Bergen: Norsildmel.

**Olcott, H. S.** (1974) Introductory remarks In: *The Economics, marketing and technology of fish protein concentrate,* (eds. S. R. Tannenbaum, B. R. Stillings and N. S. Scrimshaw) pp. 1–5. Cambridge, Massachusetts: MIT Press, 500 pp.

**Pariser, E. R.** (1968) Fish protein concentrate processing methods. In: Proceedings of a Conference of fish protein concentrate, (ed. J. Kinloch), *Can. Fish. Rep.* No. 10. pp. 65–72. Ottawa: Department of Fisheries.

**Protein Advisory Group of the United Nations System.** (1971) PAG guideline for fish protein concentrates for human consumption *PAG Guideline* No. 9. New York: UN, 6 pp.

**Rostad, O. M.** (1975) Fish protein concentrate – the protein upgrader. *Abstr. Pap. Am. Chem. Soc.* 169 AGFD 34.

**Spinelli, J., Groninger, H. S. & Koury, B.** (1974) Preparation and properties of chemically and enzymically modified protein isolates for use as food ingredients. In: *Fishery products,* (ed. R. Kreuzer), pp. 283–289. Surrey: Fishing News (Books), 462 pp.

**Tannenbaum, S. R., Stillings, B. R. & Scrimshaw, N. S.**, eds. (1974) *The economics, marketing and technology of fish protein concentrate.* Cambridge, Massachusetts: MIT Press, 500 pp.

# Fish protein concentrate from trash fish

**A. Vasantha Shenoy, M. P. Kutty Ayyappan and K. Gopakumar**
Central Institute of Fisheries Technology, India

## Summary

Fish protein concentrate (FPC) is prepared from three trash fish species, ribbon fish, catfish and kilimeen. Analytical and amino acid composition of FPC samples were carried out. FPC from all three species contained a net protein content of over 67 per cent. Protein efficiency ratio (PER) of FPC from catfish and ribbon fish were higher than casein but their net protein retention (NPR) values were lower. FPC prepared from eviscerated meat was superior in protein content and PER to that from whole fish.

## Résumé

Du concentré de protéine de poisson (FPC) est préparé à partir de poisson de rebut, dépole, poisson-chat et 'kilimeen'. La composition analytique et en amino-acide des échantillons de FPC a été effectuée. Le FPC provenant de ces trois espèces contenait un taux de protéines net de plus de 67 pour cent. Les taux d'efficacité des protéines (PER) de FPC de poisson-chat et de cépole étaient plus élevés que celui de la caséine, mais leurs valeurs de rétention nette de protéine (NPR) étaient plus basses. Le FPC préparé à partir de la chair éviscérée était supérieur en contenu protéique et en PER à celui provenant de poisson entier.

## Resumen

El concentrado de proteínas de pescado (FPC) se prepara con especies de peces de desecho como el rey de los arenques (ribbon fish), el siluro y el 'kilimeen'. Se averiguó la composición analítica y en aminoácidos de muestras de FPC. El FPC de esas tres especies tenía un contenido neto en proteínas superior al 67 por ciento. Las eficacias de utilización de proteínas (PER) del FPC preparado con siluro y el rey de los arenques (ribbon fish) eran superiores a la caseína, pero sus valores netos de retención de proteínas eran más bajos. El FPC preparado con pescado eviscerado era superior, en términos de contenido proteínico y eficacia de utilización de proteínas, al preparado a base de pescado entero.

## Introduction

In India, trash fish or miscellaneous fish form an important part of shrimp trawler catches. The percentage may vary from 50 to 70% of the total catch while shrimp accounts for the remainder. At present, they are not landed because their market value is low. Since they form a cheap source of animal protein, attempts are being made to prepare fish protein concentrate (FPC) from them. Catfish, ribbon fish and kilimeen are the important trash fish usually caught; therefore, they were taken for this specific study. FPC was prepared using these fish and the nutritional qualities were evaluated.

## Materials and methods

Fish species for the experimental work, ribbon fish (*Chirocentrus dorab* Forskal), catfish (*Tachysurus jella* Day) and kilimeen (*Nemipterous japonicas* Bloch), were obtained from the trawlers of the Indo-Norwegian Project, Cochin.

The comminuted fish meat was cooked with an equal quantity of water containing acetic acid (0.5% by volume). It was left for an hour and the fish oil which separated on the top was skimmed off. The slurry was filtered through a canvas bag and then pressed to remove water. The fat was extracted from the pressed cakes first with alcohol, which also removes moisture, and then with an aseotropic solvent mixture of hexane and alcohol (33.2 mole percentage of alcohol, BP 58.69°C), following the method of Ismail *et al.* (1968). After the solvent extractions, the defatted mass was pressed in a screw press and dried under vacuum. The dried FPC was steam stripped to remove the last traces of solvent, afterwards, it was again dried under vacuum and then powdered and packed.

Protein, moisture and ash were determined by the AOAC method (1960) and residual fat was estimated by the method of Bligh and Dyer (1959). Phosphorus was determined by the method of Fiske and Subbarow (1925) and calcium by flame photometry. The amino acid composition was estimated microbiologically (Kavanagh, 1963) and available lysine was estimated by the modified Carpenter's method of Booth (1971).

## Results and discussions

FPC, prepared from all the three types of fish (whole), was white in colour but the FPC from eviscerated meat was colourless, owing to the absence of skin and bones. The grittiness, found in the FPC from whole fish, was not so significant in the FPC from eviscerated meat; however, all four FPC samples satisfied the specifications laid down for FPC Type A (Protein Advisory Group, 1971). A comparison of the four types of FPC showed that the protein content of the three prepared from whole fish was above the standard prescribed for FPC Type A and also, FPC, from eviscerated meat, was superior to all the others (Table 1).

The FPC from eviscerated meat was also characterized by a low calcium and phosphorous content. The distribution of individual amino acids in all the three types of FPC was also similar. Analyses showed that, of the three samples of FPC (catfish, kilimeen and ribbon fish), that made from catfish contained the highest amount of protein. Among the essential amino acids, methionine, lysine, valine, leucine and isoleucine levels were significantly higher in the FPC from ribbon fish compared with the other two species (Table 2). This pattern is also seen in the available lysine values. Phenylaline was present in FPC from catfish at an elevated level.

TABLE 1. *Composition of FPC*

| *Composition* | *Kilimeen* | *Catfish* | *Ribbon fish* | *Eviscerated meat (ribbon fish)* | *FPC Type A* |
|---|---|---|---|---|---|
| % Moisture | 8.1 | 8.4 | 7.7 | 7.1 | 10.0 |
| % Protein (N x 6.25) | 67.7 | 79.2 | 78.3 | 91.5 | 67.5 |
| % Pepsin digestibility | 98.0 | 97.3 | 98.0 | 98.0 | 92.0 |
| Available lysine, % of protein | 7.9 | 7.2 | 8.3 | 9.1 | 6.5 |
| % Total lipids | 0.4 | 0.5 | 0.4 | 0.1 | 0.75 |
| % Calcium | 5.4 | 3.6 | 2.9 | 0.3 | – |
| % Phosphorus | 3.9 | 1.8 | 2.4 | 0.2 | – |
| % Ash | 24.1 | 12.9 | 14.2 | 1.4 | – |

TABLE 2. *Amino acid composition of FPC samples (total amino acids as g/100 g protein)*

| *Amino acids* | *Kilimeen* | *Catfish* | *Ribbon fish* | *Eviscreated meat (ribbon fish)* |
|---|---|---|---|---|
| Arginine | 7.016 | 5.808 | 7.151 | 6.076 |
| Tryptophan | 1.019 | 0.795 | 1.008 | 0.754 |
| Methionine | 2.998 | 2.550 | 3.246 | 3.523 |
| Lysine | 8.138 | 8.888 | 9.246 | 9.923 |
| Cystine | 2.599 | 1.868 | 2.311 | 3.092 |
| Valine | 4.815 | 5.643 | 6.615 | 5.114 |
| Leucine | 7.444 | 7.121 | 8.122 | 8.655 |
| Isoleucine | 3.958 | 3.800 | 4.137 | 3.803 |
| Threonine | 1.580 | 1.300 | 1.200 | 1.551 |
| Phenylalanine | 1.388 | 3.636 | 1.813 | 1.180 |
| Histidine | 1.580 | 1.654 | 2.311 | 2.109 |
| Tyrosine | 3.190 | 6.073 | 5.593 | 7.551 |
| Glycine | traces | traces | traces | traces |
| Glutamic acid | 21.565 | 18.813 | 14.942 | 13.770 |

PER values of FPC from catfish and eviscerated meat were higher, but their NPR values were lower, than casein (Table 3). It is reported by Spinelli *et al.* (1971) that PER of eviscerated meat (pacific herring) is appreciably higher than casein. It is seen from the studies that many of the problems associated with production of FPC, eg colour, flavour reversion and grittiness, can be overcome by using eviscerated meat (from a flesh separator which removes both skin and bones). Also, the nutritional qualities of FPC can be increased by using FPC from eviscerated meat rather than that from whole fish.

TABLE 3. *Protein efficiency ratio (PER) and net protein retention (NPR) values of FPC samples*

| *FPC* | *PER* | *NPR* |
|---|---|---|
| Casein | 2.76 | 4.6 |
| Kilimeen | 2.34 | 3.5 |
| Catfish | 2.92 | 3.26 |
| Eviscerated meat (ribbon fish) | 3.12 | 3.86 |

*PER and NPR values determined at 10% protein level.

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## References

**Association of Official Agricultural Chemists.** (1960) *Official methods of analysis,* 9th edn. Washington, DC: AOAC, 832 pp.

**Bligh, E. G. & Dyer, W. J.** (1959) A rapid method of total lipid extraction and purification. *Can. J. Biochem. Physiol.*, **37**, 911–917.

**Booth, V. H.** (1971) Problems in the determination of FDNB – available lysine. *J. Sci. Food. Agric.*, **22**, 658–664.

**Fiske, E. H. & Subbarow, Y.** (1925) The colorimetric determination of phosphorus. *J. Biol. Chem.*, **66**, 375–400.

**Ismail, P. K., Madhaven, P. & Pillai, V. K.** (1968) Preparation of fish protein concentrate. *Fish Technol.*, **5** (1), 53–59.

**Kavanagh, F., ed.** (1963) *Analytical microbiology,* vol. 1. New York: Academic Press, 707 pp.

**Protein Advisory Group of the United Nations System.** (1971) PAG guideline for fish protein concentrates for human consumption. *PAG Guideline* No. 9 New York: UN, 6 pp.

**Spinelli, J., Dyer, W. J., Lenham, L. & Wieg, D.** (1971) The fish protein concentrate story. 13. Aqueous phosphate processing. *Food Technol.*, **25**, 713–717.

# Comparative study of fish ensilage prepared by microbial fermentation and formic acid ensilage

**M. A. James, K. M. Iyer and M. R. Nair**
Central Institute of Fisheries Technology, India

## Summary

Ensiled fish products were prepared from jewfish (*Pseudosciaena* spp.), silver bellies (*Leiognathus* spp.) and sole fish (*Cynoglossus semifasciatus*) by microbial fermentation and by the formic acid method. Their nutritive values were compared. Composition of each silage product was reported and changes in the protein occurring during fermentation and storage were described. Utilizing small fish and fish waste into useful liquid products for animal feed, is considered.

## Résumé

Les produits d'ensilage de poisson ont été préparés à partir de poisson-juif (*Pseudosciaena* spp.), de poisson d'argent (*Leiognathus* spp.) et de sole (*Cynoglossus semifasciatus*) par fermentation microbienne et par la méthode à l'acide formique. Leurs valeurs nutritives ont été comparées. La composition de chaque produit d'ensilage a été donnée et les modifications protéiques survenant au cours de la fermentation et du stockage ont été décrites. L'utilisation de petits poissons et de déchets de poisson sous la forme de produits liquides utiles pour l'alimentation des animaux est étudiée.

## Resumen

Se prepararon productos de pescado ensilado con roncadores (*Pseudosciaena* spp.), 'silver bellies' (*Leiognathus* spp.) y lenguado (*Cynoglossus semifasciatus*) por fermentación microbiana y por el método del ácido fórmico. Se compararon sus valores nutritivos. Se tomó nota de la composición de cada producto ensilado y se describieron los cambios que ocurrieron en las proteínas durante la fermentación y el almacenamiento. Se analiza también la utilización de peces pequeños y residuos de pescado en productos líquidos útiles para alimentación animal.

## Introduction

Considerable interest has developed during recent years in the preparation of liquid fish products for animal feeds (McBride *et al.*, 1961; Nilsson and Rydin, 1961, unpublished work; James, 1966; Tatterson and Windsor, 1973). Ensilage or liquid preservation was achieved either directly, using mineral acids or organic acids (such as formic acid), or by microbial fermentation with lactic acid producing micro-organisms. In the fermentation method, the fish and fish waste are preserved and partly digested by the lactic acid produced. To achieve pH 4 to 4.5 a sufficient quantity of lactic acid must be produced during fermentation. This is brought about by adding molasses as a fermantable carbohydrate. Biological ensiling has been considered preferable because a rancid odour does not develop in the products (Nilsson and Rydin, 1961, unpublished work).

Fish, with its high protein content, can be a good substrate for biological ensiling, particularly in warm and humid climates. It is generally in the form of a semisolid having good keeping qualities with little oxidative and hydrolytic rancidity of the fat. Nilsson and Rydin (1961) have demonstrated that ensiling by the microbial process (where lactic acid production is increased by the addition of a mixture of enzymatically active barley malt and wheat flour) gives better products than those produced by adding strong mineral acids. Recently Tatterson and Windsor (1974) described the preparation of six types of formic acid silage, made from different fish and fish waste, and showed that during a year's storage at different temperatures (20 and 23°C) these products were stable.

The present study was initiated to compare microbial fermentation and formic acid ensiling by investigating the changes occurring in the protein (with reference to water soluble nitrogen) non-protein nitrogen and free amino acids during storage at ambient temperature.

### Materials and methods

Silver bellies (*Leiognathus* spp.), jewfish (*Pseudosciaena* spp.) and sole fish (*Cynoglossus semifasciatus*) were obtained fresh from fishing vessels operating at Cochin. The fresh fish, after cleaning, were minced well in an electrical meat mincer and divided into two parts. One part was mixed with 15% by weight of commercial molasses and made into a slurry with 30% by weight of water. To this was added an active culture of *Lactobacillus plantarum* (homofermenter producing lactic acid), and the slurry was frequently and thoroughly mixed and allowed to ferment at room temperature (28 ± 2°C). To the other part of the minced fish, 5% by weight of formic acid (98% pure) was added and mixed thoroughly by stirring. This was also stored at room temperature with frequent stirring.

The prepared products were stored in plastic containers (with lids) for one year and were analysed for their composition and changes of protein during fermentation. Total nitrogen, water soluble nitrogen, non-protein nitrogen and ash content were estimated using the methods reported by James (1966). Lactic acid was estimated by the AOAC method (1960) and free amino acids were determined by microbiological methods (Kavanagh, 1963).

### Results and Discussion

The general composition of these silages was similar. Comparative protein nitrogen distribution analyses obtained from different fish ensilages are given in Table 1. The protein nitrogen ranged from 1.79 to 2.14% in the fermented silage, whereas formic acid silage gave values 2.24 to 2.57%. The lower protein nitrogen content in the biological ensilage is due to the addition of carbohydrates and slight dilution. A similar trend was also noticed in the water soluble nitrogen. Non-protein nitrogen and ∝ -amino nitrogen were slightly higher in the lactic acid silages. It was noticed that no unpleasant odour had developed in these products while the formic acid had a slight, pungent odour.

In the acid ensilages the pH was brought to 4.0 by adding formic acid to the level of 5% by weight of fish material. Tatterson and Windsor achieved a lower pH by adding 3% by weight but the higher concentration of formic acid was found essential in our experiments; different amounts of acids may be required under different climatic conditions. In the biological fermentation, pH 4 to 4.5 was attained after 72 hours and slight bacterial degradation was present in the initial 24 hours. From Table 2 it can be seen that the free amino

TABLE 1. *Nitrogen distribution and ash content in different fish ensilages*

| | *Formic acid ensilage* | | | *Microbial fermentation* | | |
|---|---|---|---|---|---|---|
| *Composition* | *Silver bellies* | *Jewfish* | *Sole fish* | *Silver bellies* | *Jewfish* | *Sole fish* |
| Crude protein N% | 2.24 | 2.57 | 2.48 | 1.79 | 2.14 | 1.94 |
| Water soluble N% | 1.79 | 2.05 | 1.98 | 1.43 | 1.71 | 1.55 |
| Non-protein N% | 0.42 | 0.36 | 0.39 | 0.56 | 0.61 | 0.49 |
| ∝-Amino N% | 0.26 | 0.24 | 0.21 | 0.38 | 0.42 | 0.36 |
| Ash content% | 2.19 | 2.43 | 2.46 | 2.42 | 2.76 | 2.51 |

TABLE 2. *Free amino acid composition of different fish ensilages (mg %)*

| | *Formic acid ensilage* | | | *Microbial fermentation* | | |
|---|---|---|---|---|---|---|
| *Amino acids* | *Silver bellies* | *Jewfish* | *Sole fish* | *Silver bellies* | *Jewfish* | *Sole fish* |
| Glumatic acid | 81.4 | 88.7 | 83.1 | 189.1 | 198.3 | 181.7 |
| Alanine | 70.1 | 81.4 | 76.3 | 162.3 | 178.1 | 168.3 |
| Arginine | 52.6 | 64.2 | 58.3 | 113.7 | 138.7 | 128.6 |
| Tyrosine | 48.3 | 59.6 | 49.7 | 103.3 | 121.7 | 113.1 |
| Lysine | 46.7 | 51.3 | 49.1 | 98.4 | 107.3 | 105.8 |
| Methionine | 42.1 | 49.3 | 43.7 | 89.4 | 93.5 | 101.9 |
| Valine | 37.4 | 30.8 | 32.7 | 81.3 | 92.7 | 99.7 |
| Threonine | 24.5 | 21.7 | 19.8 | 72.4 | 78.9 | 75.3 |
| Proline | 10.1 | 12.9 | 8.1 | 21.6 | 28.3 | 32.7 |
| Leucine | 3.1 | 2.4 | 1.3 | 10.3 | 12.7 | 17.4 |
| Isoleucine | 1.8 | 1.7 | 0.9 | 7.6 | 9.3 | 6.3 |
| Histidine | 2.1 | 1.9 | 1.1 | 6.3 | 7.8 | 5.1 |
| Cystine | 1.2 | 0.9 | 0.7 | 5.3 | 5.9 | 4.6 |
| Glycine | 1.3 | 1.1 | 1.9 | 4.3 | 5.2 | 4.1 |
| Serine | 1.7 | 1.3 | 1.5 | 3.9 | 4.3 | 3.1 |
| Tryptophan | 0.8 | 0.6 | – | 0.9 | – | 0.6 |

TABLE 3. *Increase of water soluble nitrogen (expressed as % total nitrogen) during ensiling and storage*

| | *Formic acid ensilage* | | | *Microbial fermentation* | | |
|---|---|---|---|---|---|---|
| *Storage (days)* | *Silver bellies* | *Jewfish* | *Sole fish* | *Silver bellies* | *Jewfish* | *Sole fish* |
| 7 | 50.6 | 51.5 | 49.7 | 29.5 | 31.3 | 30.7 |
| 14 | 71.7 | 70.1 | 73.8 | 51.7 | 52.3 | 50.6 |
| 21 | 79.6 | 78.9 | 82.4 | 61.7 | 59.8 | 60.4 |
| 30 | 80.2 | 81.7 | 81.9 | 60.8 | 61.1 | 59.8 |
| 60 | 80.1 | 81.3 | 81.1 | 59.8 | 60.9 | 60.3 |
| 180 | 79.9 | 80.8 | 80.7 | 60.1 | 59.8 | 61.2 |
| 360 | 80.9 | 79.3 | 80.1 | 59.9 | 60.1 | 60.7 |

acids were higher in the biologically fermented products. The predominant amino acids were glutamic acid, alanine, arginine, tyrosine, lysine, methionine, valine and threonine, the other amino acids were comparatively low in concentration.

Protein breakdown was found to be greater with formic acid digestion. During the first seven days, water soluble nitrogen increased rapidly to 50% of the total nitrogen whereas biological ensiling gave a lower value of 30% of total nitrogen (Table 3).

At the end of 21 days, digestion (monitored by the increase in water soluble nitrogen) in the acid ensilage increased to 80% of total nitrogen and was stable for one year. This agrees with the findings of Tatterson and Windsor. Digestion in the fermented silage reached its maximum, 60% of total nitrogen, in 21 days; thereafter negligible changes occured throughout the year. It is interesting to note that the digestion of protein in the biologically fermented silage is lower than the one ensiled in formic acid due to partial preservation by the lactic acid produced.

Changes occurring in the free amino acid composition of both silages during storage were studied. A slight increase in the free amino acids was found during the first six months' storage, and afterwards, a slight overall decrease was noted in both the prepared silages. The loss of amino acids during the later stages of storage in the biological ensilage may be due to their interaction with sugars in the unutilized molasses. Methionine, cystine, tryptophane, tyrosine, glutamic acid, proline and lysine were the amino acids most affected.

The fresh ensilage products were tested for pathogenic organisms such as *Salmonella,* faecal streptococci and coliforms; all of them were absent. After one year's storage (at 28 ± 2°C), total counts for the two ensilages were as follows:–

Lactic acid ensilage, $1.8 \times 10^3$/g (initial counts; $6.8 \times 10^7$/g)

Formic acid ensilage, $1.2 \times 10^2$/g (initial counts; $2.1 \times 10^5$/g)

## Conclusions

The liquid ensilage products prepared by both the methods were highly stable and did not require neutralization prior to animal feeding. The formic acid products gave pungent odours while the others gave agreeable odours. The protein digestion in the biological method was lower than with the formic acid silage. In both methods, the free amino acids decreased after six months of storage. The pH of the medium did not change appreciably from 4 to 4.5 during storage.

In India, an abundant supply of cheap molasses, which could be utilized as a fermentable carbohydrate for the preparation of biological ensilage, is available. A ready-mixed poultry feed could be prepared by adding de-oiled rice bran with fish ensilage in the ratio 1:1 or 1:2 and drying to a moisture level of less than 10%; the product is highly suited for poultry rations. Preliminary trials with poultry feed showed that the growth rate and yield of eggs increased. This simple process has been found to be technically feasible for the conversion of miscellaneous fish into animal feed.

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## References

**Association of Official Agricultural Chemists.** (1960) *Official methods of analysis,* 9th edn. Washington, DC: AOAC, 832 pp.

**James, M. A.** (1966) Ensiled products from fish by microbial fermentation. *Fish. Technol.,* **3** (1), 38–43.

**Kavanagh, F., ed.** (1963) *Analytical microbiology,* vol. 1. New York: Academic Press, 707 pp.

**McBride, J. R., Idler, D. R. & McLeod, R. A.** (1961) The liquefaction of British Colombia herring by ensilage, proteolytic enzymes and acid hydrolysis. *J. Fish. Res. Board Can.,* **18** (1), 93–112.

**Pope, C. G. & Stevens, M. F.** (1939) Determination of amino nitrogen using a copper method. *Biochem. J.,* **33** 1070–1077.

**Tatterson, I. N. & Windsor, M. L.** (1973) *Fish Mark. Process. Packag.,* February, 16.

**Tatterson, I. N. & Windsor, M. L.** (1974) Fish silage. *J. Sci. Food Agric.,* **25**, 369–379.

# Low salt fermentation method for conserving trash fish waste under SE Asian conditions

**W. R. Stanton**
University of Malaya, Malaysia
and
**Quee Lan Yeoh**
Malaysian Agricultural Research and Development Institute, Malaysia

## Summary

This fermentation method for the conservation of trash fish and fish waste has a number of features which make it attractive for operation in a tropical developing country. The cost of fishing operations has increased dramatically in the last few years and so has the potential value of the component which has hitherto been discarded by direct return to the sea. The quantity of salt required for safe preservation by traditional methods limits the utility of the end-product. Conservation by refrigeration or dehydration demands excessive energy and the practice of sun drying, as used on land, cannot be applied at sea. Added mineral acids and preservatives also limit the use of the end-product, as well as adding to the cost. We are, therefore, investigating a self-generated, organic acid fermentation system using a local carbohydrate assisted by malt substitutes. (For SE Asia the preferred material is 'ragi' which is a product commonly found in the markets. It consists of a mixed culture of amylolytic moulds and yeasts cultured in rice flour and dried).

Sauerkraut equivalent fermentations have been used to provide the starter for early experiments although, if this method were to be used for a continuous batch process, provision of the starter would present no problem. Initial experiments indicate that at ambient equatorial temperatures these fermentations produce acceptable end-products (provided the fish are sufficiently finely communuted) and inhibit or destroy unwanted organisms. The method, therefore, shows promise for application to the fishing communities of areas such as SE Asia, where the experiments reported in this paper were conducted.

## Résumé

Cette méthode de fermentation pour la conservation des poissons de rebut et des déchets de poisson possède un certain nombre de caractéristiques qui rendent intéressante sa réalisation dans les pays tropicaux en voie de développement. Le coût des opérations de pêche a augmenté de façon dramatique au cours des dernières années ainsi que la valeur potentielle du produit qui jusqu'alors était éliminé et rejeté directement à la mer. La quantité de sel exigée pour une conservation efficace par les méthodes traditionnelles limite l'intérêt du produit obtenu. La conservation par réfrigération ou déshydratation exige une quantité excessive d'énergie et la pratique du séchage au soleil utilisée à terre ne peut être utilisée en mer. L'adjonction d'acides minéraux et de conservateurs, ainsi que l'augmentation du prix qui en résulte limitent également l'utilisation du produit fini. Nous nous efforçons donc de rechercher un système de fermentation par acide organique auto-entretenu utilisant un carbohydrate local ainsi que des produits de remplacement du malt. (Pour la partie Sud-Est de l'Asie, le matérial préféré est le 'ragi' qui est un produit que l'on trouve couramment sur le marché. Il consiste en une culture formée d'un mélange de substances amylolytiques et de levures cultivées sur la farine de riz et desséchées).

Des fermentations semblables à celles de la choucroute ont été utilisées pour produire le déclenchement du processus au cours des premières expérimentations et si cette méthode devait être utilisée pour une opération continue, l'approvisionnement en produits de déclenchement ne poserait aucun problème. Les expérimentations initiales ont indiqué qu'à la température ambiante équatoriale, ces fermentations produisent un produit fini acceptable (à condition que le poisson soit haché assez finement) et inhibe ou détruise les organismes non désirables. L'utilisation de cette méthode semble donc intéressante pour les entreprises de pêche des régions comme le Sud-Est Asiatique où les expérimentations présentées ici ont été réalisées.

## Resumen

Este método de fermentación para la conservación de pescado de desecho y residuos de pescado tiene unas características que hacen su utulización muy atractiva para un país tropical en vías de desarrollo. El costo de las operaciones de pesca ha aumentado de forma dramática en los últimos años, e igualmente el valor potencial de la parte que se rechazaba hasta ahora devolviéndola directamente al mar. La cantidad de

sal que se requería para preservarlo de forma segura por los métodos tradicionales limita la utilidad del producto final. La conservación por refrigeración exige demasiada energía, y la práctica de secado al sol, utilizada en tierra, no es aplicable en el mar. La adición de ácidos minerales y preservativos limita también el uso del producto final y además aumenta el costo. Se está, por tanto, investigando do sobre un sistema de fermentación por ácidos orgánicos autogenerados, utilizando hidratos de carbono locales y sustitutos de la malta. (En el sureste de Asia el material preferido es el 'ragi', que es un producto muy abundante en los mercados. Consiste en un cultivo mixto de mohos amilolíticos y levaduras cultivadas en harina de arroz y secado.) Se han utilizado fermentaciones equivalentes a la de la chucruta para suministrar un iniciador de la fermentación en experimentos anteriores, aunque si se fuera a utilizar este método para un proceso continuo en serie, la provisión de un iniciador no presentaría problemas. Experimentos iniciales muestran que estas fermentaciones en temperaturas de ambiente ecuatorial dan lugar a productos finales aceptables (siempre que el pescado esté suficientemente desmenuzado) e inhiben o destruyen los organismos indeseables. El método es, por tanto, prometedor para aplicarlo en las comunidades pesqueras de zonas como el sureste de Asia donde se han llevado a cabo los experimentos.

## Introduction

Fermentation methods have been widely employed to conserve or utilize surplus products. These products have included fish and fish wastes and the methods employed, for fermentation, may be divided into four groups:

*Group 1:* those employing high salt concentrations, with 15 to 20% salt in the final product (van Veen and Steinkraus, 1970). Most of the traditionally fermented fish products of SE Asia, for example the 'nam-pla' of Thailand and 'budu' of Malaysia, are in this group. The main disadvantage of this method, for production of a foodstuff, is that the protein intake is limited by the high salt content and these products are used more as condiments.

*Group 2:* those employing preservatives or mineral acids to limit or eliminate the microflora. This is the principle of the method of acidification in the making of silage developed by Virtanen in 1929 (Wirahadikusumah, 1968). AIV (Artturi I. Virtanen) silage is produced by the addition of strong acids, for example sulphuric and hydrochloric acids, to forage crops. However, the use of corrosive chemicals which require care in handling is a distinct disadvantage. Furthermore, the silage has to be neutralized before feeding to animals and the large amounts of silage juices produced pose disposal problems (Nilsson, 1969).

*Group 3:* those employing an initial dosage of organic acids or other preservative agents rather than mineral acids. This method has been applied to the preservation of fish to produce chemical silage by the addition of organic acids such as formic acid (Tatterson and Windsor, 1974). Its disadvantage, like that of group 2 for a SE Asian country, is the lack of expertise at the village level for the handling of strong acids as well as adding to the cost of the process.

*Group 4:* those employing a process of fermentation with the generation of organic acids, or other preserving materials, to conserve the product. We have confined ourselves to this group of processes which has a number of advantages, from the point of view of their utilization under SE Asian conditions, in that they do not require the utilization of imported additives or chemicals which might be dangerous at high concentrations. The basic techniques for the preservation of forage crops by this method were established by the Department of Microbiology of the Agricultural College of Sweden; the method was then extended to the ensilage of other raw materials, such as meat and fish. A summary of the four fermentation methods is given in Table 1.

TABLE 1. *Summary of fermentation methods*

| *Group* | *Product* | *Preservation method* | *Comments* |
|---|---|---|---|
| 1 | Fermented fish products of SE Asia eg 'nam-pla' (Thailand), 'budu' (Malaysia) | Addition of 15–20% salt, anaerobic fermentation | High salt content limits protein intake |
| 2 | AIV silage for forage crops and other animal proteins | Addition of strong acids eg hydrochloric and sulphuric acids | Danger in handling strong acids<br>Requires neutralization before feeding<br>Large production of silage juices |
| 3 | Chemical silage for forage crops and fish | Addition of organic acids | As group 2 |
| 4 | Biological silage for forage and fish | Fermentation by lactic acid bacteria | Most suitable for SE Asian conditions |

We are interested in applying this method to the conservation of fish under SE Asian conditions and in utilizing locally available materials. To achieve this, we are using local carbohydrate sources such as tapioca starch (cassava, manioc starch from *Manihot esculenta* Cranz), tapioca flour and sago (*Metroxylone sagus* Roettb) and, as a malt substitute, an indigenous fermentation starter called 'ragi'.

The end-product of the fermentation could potentially be used for either human food or animal feed although, in our initial work, we have concentrated on the latter. However, it would appear that, in the long term, these fermented low salt products might be of advantage for the human market; this would be subject to the observation of the necessary food safety precautions, mainly to avoid hazards arising from toxin-producing micro-organisms and heavy metals.

## Lactic acid fermentation of fish

The successful preservation of the fish by biological fermentation methods is dependant on the production of lactic acid (von Hofsten and Wirahadikusumah, 1972). In biological silages, lactic acid bacteria ferment the sugars present to organic acids; this results in a lowering of the pH. If the pH is sufficiently reduced, growth of putrefactive organisms and pathogens is inhibited (Carr, 1975).

Fish contain only small amounts of fermentable carbohydrates and work carried out in Sweden, by Nilsson and his colleagues, has shown that the addition of suitable carbohydrates improves fermentation. Addition of mixtures of malt and cereal meal, molasses and cereal meal, malt and tapioca meal, and molasses and tapioca meal (Nilsson and Rydin, 1963; Nilsson, 1969) have all proved successful.

The fermentation process for the conversion of carbohydrates to lactic acid is anaerobic and can be divided into three stages (Wirahadikusamah, 1968). Initially, the starch of the carbohydrate source is hydrolysed to malt by $\alpha$ and $\beta$ amylase. The maltose molecules are then further broken down to glucose by maltase. The last step in the fermentation is the conversion of glucose to lactic acid by lactic acid bacteria. Small amounts of other substances, such as acetic acid and alcohol, are also formed.

Lactic acid bacteria can be divided into two groups, the homofermentative group and the heterofermentative group (Hardy *et al.*, 1971). The homofermentative lactic acid bacteria produce two moles of lactic acid per mole of glucose while the heterofermentative bacteria produce only one mole of lactic acid together with ethyl alcohol and cabon dioxide. Therefore, for a successful fish silage fermentation, a predominance of homofermentative strains appears to be desirable. Although lactic acid bacteria are widespread in nature, they are not found in large numbers in fish microflora. It is, therefore, essential to add a starter culture of lactobacilli for a successful fermentation.

There are a number of possible methods of adding lactobacilli, including the addition of pure starter cultures. However, in our initial investigations, actively growing cultures from sauerkraut or sauerkraut equivalent fermentations, such as the 'Kim-chi' of Korea, were used (Mheen, 1972). The sauerkraut is made from sliced cabbages mixed with 2.5% salt and packed tightly in a 2 litre jar. A glass 'thief' is placed in the centre of the jar and the expressed juice, containing the lactic acid bacteria, is drawn via the 'thief' for use as inoculum. The sauerkraut fermentation starts spontaneously and a vigorous lactic acid fermentation takes place resulting in a rapid drop in pH; the fermentation is carried out at ambient temperature (29°C). For our experiments, the inoculum was drawn from four-day-old sauerkraut fermentations which had a pH of approximately 3.5, a lactic acid bacterial count of 1.0 to $3.0 \times 10^8$ organisms/$cm^3$ and a titratable acidity of 1.2 to 1.5% lactic acid. At this stage of the fermentation, the inoculum consisted of a mixture of *Pediococcus cerevisiae*, *Lactobacillus brevis* and *Lactobacillus plantarum;* the coliform count was zero. For scaling up the process, an inoculation using a sample of the silage itself may be used as a starter.

Since the lactic acid bacteria are unable to act on unhydrolysed starch, it is necessary to supply an amylolytic agent. This is usually enzymes from malt but we prefer to use a malt substitute which is available locally. It is normally used for the fermentation of glutinous rice in the production of 'tapai'. In the traditional method of manufacture, clean rice flour is mixed with water to make a thick paste from which small balls are prepared. Some 'ragi' from a previous batch is powdered and sprinkled as inoculum over the balls which are then placed on a bamboo tray, covered with muslin and allowed to ferment and dessicate simultaneously at room temperature for two to five days (Susono *et al.*, 1974). This process would require modification if it were to be applied to climates other than those of equatorial rain forest regions.

A number of workers have shown that there is a wide variety of fungi and yeasts found in samples of 'ragi' from different sources. Table 2 gives a summary of the species found in the samples.

As the production of 'ragi' is not a controlled process, it is possible that many of the organisms present are contaminants and are not important to the fermentation process. The only fungi of interest to us are those with amylolytic properties, such as *Chlamydomucor oryzae* (Ko, 1972), which are able to hydrolyse the starch to fermentable sugars. However, 'ragi' is a good indigenous source of amylase; it is cheap, easily available and has good keeping qualities. Preliminary studies by von Hofsten and Wirahadikusumah (1972) have shown that a Japanese type of 'koji' could also be used for this purpose.

For the purpose of the present studies, the fish silage was made by the following method. Whole trash fish were rinsed, drained and minced using a meat mincer. Varying quantities of tapioca starch were added as the carbohydrate source. 'Ragi' and a starter culture of lactobacilli were added at the rate of 2% of the total

TABLE 2. *Mycoflora or 'ragi'*

| *Class* | *Order* | *Family* | *Genus* | *Species* |
|---|---|---|---|---|
| Phycomycetes, sub-class Zygomycetes | Mucorales | *Mucoraceae* | *Mucor* | *M. circinelloides*[1] |
| | | | | *M. dubius*[2] |
| | | | | *M. javanicus*[2] |
| | | | | *M. rouxii*[2] |
| | | | *Rhizopus* | *R. arrhizus*[3] |
| | | | | *R. oligosporus*[3] |
| | | | | *R. oryzae*[2] |
| | | | | *R. stolonifer*[2] |
| | | | *Chalmydomucor* | *C. oryzae*[2] |
| Fungi imperfecti | Hyphomycetales | *Aspergillaceae* | *Aspergillus* | *A. flavus*[3] |
| | | | | *A. niger*[2] |
| | | | | *A. oryzae*[3] |
| | | *Tuberculariaceae* | *Fusarium* | *Fusarium* spp.[1] |
| | Cryptococcales | *Cryptococcaceae* | *Torula* | *T. indica*[2] |
| | | | *Candida* | *C. guilliurmondii*[1] |
| | | | | *C. humicola*[1] |
| | | | | *C. lactosa*[3] |
| | | | | *C. melinii*[3] |
| | | | | *C. solani*[3] |
| Ascomycetes | Ascomycetales | *Endomycetaceae*<br>Tribe A:<br>*Endomycopseae* | *Endomycopsis* | *E. chodati*[4] |
| | | | | *E. fibuliger*[4] |
| | | Tribe B:<br>*Saccharomycetaceae* | *Hansenula* | *H. malanga*[3] |
| | | | | *H. subpelliculosa*[3] |
| | | | *Saccharomyces* | *S. cerevisiae*[1] |

Source: [1] Susono *et al.*, 1974
[2] Ko, 1965
[3] Dwidjoseputro and Wolf, 1970
[4] Ko, 1972

weight of the fish/starch mixture. The final mixture was then placed in cylinders sealed with vaspar or in glass containers fitted with air-tight lids. The fermentations were conducted at 29°C (to avoid the use of refrigeration in handling and storage) with another set at 10°C as a low temperature control for comparison with previous studies.

Successful fermentations were indicated by some gas production and a rapid drop in pH to below 4.5. The resulting products had an acidic smell and could be kept for several months in closed containers. The length of the fermentation varied with the raw materials used and with the temperature. According to von Hofsten and Wirahadikusumah (1972), a good silage should contain mainly lactic acid and little butyric acid; the presence of butyric acid bacteria makes the silage unsuitable for feeding livestock since they are carried over into the milk (Nilsson *et al.*, 1956). The ratio of ammonia nitrogen and total nitrogen should also be as low as possible. Work by Wirahadikusumah (1968) showed that this method of fish fermentation prevented fat rancidity and destroyed pathogens including *Clostridium botulinum.*

Fish silage feeding trials have shown that it is a good protein source for cattle (Ley, 1975), broilers and laying hens (von Hofsten and Wirahadikusumah, 1972).

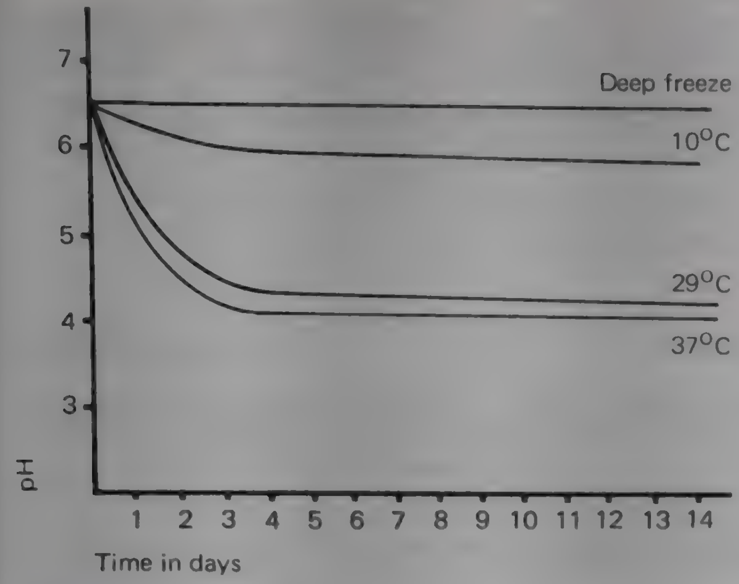
### Fermentation results and discussion

As the degree of comminution of the fish affects the success of the fermentation, it is useful to determine the efficiency of mincing. For this work, a Laska meat mincer was used. The fish was minced for 8 to 10 minutes until visually homogeneous. Then 50g of the fish slurry were suspended in 450 cm$^3$ of deionised water; this diluted slurry was put through a fine kitchen sieve (25 mesh/in). The fish mince retained in the sieve was washed twice with 100 cm$^3$ of water and allowed to drain for five minutes. It was then weighed and the percentage retention was calculated on a dry weight basis; it was found that 48 to 50% of the fish mince was retained. It was assumed that, if more than 50% of the fish particles were fine enough to pass through the sieve, the mincing was sufficient.

Trials initially carried out show that the change in pH occurred more rapidly for the fermentations at 29°C than those at 10°C. The pH dropped to 4.9 by the second day and was below 4.5 by the third day from an initial level of pH 6.5 for the experiments carried out at 29°C. For the 10°C fermentation, the pH dropped to 5.95 by the sixth day but, even after two weeks, remained above pH 5. The results are illustrated in Figure 1.

These results are similar to those obtained at the UNESCO/ICRO work study at Bandung, Indonesia, in 1974 and at the work study in Kuala Lumpur, Malaysia, 1972. The work study at Bandung also carried out fermentations at deep-freeze temperatures, where no change of pH was observed. In the report by von Hofsten and Wirahadikusumah (1972), they stated that even more rapid drops in pH may be expected at higher temperatures and successful fermentations have been carried out at 37°C. However, this series of experiments has shown that successful fermentations can be carried out at ambient temperature (29°C) using a mixture of

**Figure 1**
**pH changes in fish silage**



50% fish and 50% tapioca starch.

Trials were also carried out with varying amounts of minced fish and starch. The pH and lactic acid content were used as indications of the course of the fermentation and to determine the success of the process. The initial moisture contents of the mixtures and the percentage dry matter on harvesting were also determined. A summary of the results of a typical set of experiments carried out at 29°C is given in Table 3.

The results indicate that the best ratio of fish to tapioca starch for the type of trash fish used in these experiments is 1:1; a ratio of fish to starch of 3:2 also produces an acceptable silage. However, for lower concentrations of starch, the pH was not reduced sufficiently for it to have a preservative effect.

Batch E, in particular, spoilt very rapidly and had to be thrown out by the third day. Batch D also gave off a foul odour after the fourth day. Batch C could not be kept for more than a week because the pH was not lowered sufficiently but batches A and B could be kept for a few weeks. The pH of batch B continued to fall slowly and reached pH 4.60 after two weeks. Insufficient lactic acid was produced in some of the batches to cause a sufficiently rapid fall in pH. This was attributed to various factors such as too high an initial moisture content, inadequate amounts of carbohydrate, insufficient amounts of amylolytic enzymes or a combination of all three factors.

In another series of experiments, the microbial content of the fish silage was monitored. The samples were analysed for coliforms only using violet red bile agar (incubated at 37°C for 24 hours) and lactic acid bacteria were enumerated using the method described by Pederson and Albury (1969). In these trials the species of lactic acid bacteria were not identified but, according to von Hofsten and Wirahadikusumah (1972), the initial stage of the fermentation shows a predominance of *Leuconostoc mesenteroides.* After two days, the number of these bacteria drops rapidly and the fermentation is carried on by *Streptococcus faecalis.* After 5 days, the *S. faecalis* is inhibited by the high acidity and the final stage is predominated by *Lactobacillus plantarum.*

The concentration of the lactic acid starter culture used for this set of experiments was 1.0 x $10^8$ bacteria/$cm^3$ and the coliform count was zero. The results for the microbial analysis of fish silage are given in Table 4.

It can be seen from the results that in a successful silage the number of coliforms/g falls, eg in batches A and B. With higher acid concentrations the coliforms may be eliminated completely. On the other hand, the total viable count shows an increase for all samples. Most of the organisms were identified as lactic acid bacteria since the morphological characteristics of the colonies were typical of those described for lactobacilli by Pederson and Albury (1969). However, there are more non-characteristic surface colonies growing in batches C and D than in A and B. The results show that the fish silage mixture provides a suitable substrate for the growth of lactobacilli and, with the proper conditions, a highly acidic silage may be produced.

Preliminary experiments were also carried out to determine the effect of salt addition to the fish/carbohydrate mixture. Three proportions of salt were used, 1, 2 and 5%; no slat was added to the control. The fish:starch:'ragi' ratio was 80:15:5 with

TABLE 3. *Analysis of fish silage*

| | *Initial* | | | *After 3 days* | | |
|---|---|---|---|---|---|---|
| *Fish:starch Ratio* | *pH* | *% Lactic acid* | *% Moisture* | *pH* | *% Lactic acid* | *% Dry matter* |
| A 1 : 1 | 6.55 | 0.20 | 43.58 | 4.50 | 1.58 | 56.81 |
| B 6 : 4 | 6.45 | 0.25 | 49.58 | 5.00 | 1.33 | 50.23 |
| C 7 : 3 | 6.45 | 0.29 | 55.42 | 5.45 | 1.26 | 44.84 |
| D 8 : 2 | 6.45 | 0.25 | 61.67 | 6.10 | 1.04 | 39.18 |
| E 9 : 1 | 6.50 | 0.40 | 67.52 | 6.72 | 0.78 | – |

TABLE 4. *Microbial counts of fish silage*

| | *Initial* | | *After 3 days* | |
|---|---|---|---|---|
| *Fish:Starch Ratio* | *Coliforms/g* | *Total count/g* | *Coliform/g* | *Total count/g* |
| A 1 : 1 | 8.0 x $10^5$ | 7.0 x $10^7$ | 1.6 x $10^3$ | 9.7 x $10^8$ |
| B 6 : 4 | 3.8 x $10^6$ | 1.4 x $10^8$ | 2.1 x $10^4$ | 2.5 x $10^9$ |
| C 7 : 3 | 4.5 x $10^6$ | 3.1 x $10^8$ | 2.0 x $10^5$ | 2.7 x $10^9$ |
| D 8 : 2 | 5.1 x $10^6$ | 3.7 x $10^8$ | 3.0 x $10^6$ | 3.1 x $10^9$ |

2% of starter culture. The fermentation were carried out at 29°C.

It was found that the reaction started very rapidly. Within four hours, the volume of the batch with 1% salt and the control had doubled due to gas production while the 2% salt batch had increased by 50%; the batch with 5% salt showed a very slight increase in volume. Furthermore, all batches, except for the 5% salt, showed some degree of proteolytic breakdown. After 24 hours, the pH of the control and 1% salt batches showed a slight increase while those with 2% and 5% salt showed a slight decrease. By 48 hours, the first two batches had spoilt whereas the batch with 2% salt had a pH of 6.0 and a slight off-odour. The batch with 5% salt, however, did not have a fishy odour or give off any bad smells although the pH was approximately 5.7. Thus, it seems that addition of 5% salt helps to retard putrefaction and this method merits further investigation. Using this method, a high fish to carbohydrate ratio could be used, which would prove more economical in practice.

The work carried out so far indicates that fish silage can be made successfully under local ambient conditions using local raw materials. The process does not need aseptic precautions; it is impractical to conduct it aseptically. Although the process is simple, it is controlled and certain precautions must be observed for a good fermentation. The first is the intimacy of the admixture of starch and fish. The fish has to be finely comminuted and thoroughly mixed with the starch and other additives. A sufficient amount of carbohydrate has to be added to supply a fermentable source of sugars; the amount necessary depends on the type of carbohydrate and species of fish and has to be determined for each type of raw material. However, the amount of carbohydrate can vary from 10 to 50% of the total weight.

The addition of an amylolytic enzyme source is also necessary so that the starch or carbohydrate can be hydrolysed to sugars. A starter culture of lactic acid bacteria is also essential in order to cause a rapid drop in the pH of the mixture and prevent putrefaction. Finally, the fermentation should be carried out under anaerobic conditions to favour the growth of the lactic acid bacteria.

The earlier experiments have shown that mixtures of fish and carbohydrate in a 1:1 ratio will produce successful silages. However, the volume of carbohydrate that has to be added could prove uneconomical. The alternative approach of adding small quantities of salt would appear to be more practical since the amount of carbohydrate required is much less.

At this stage of the work, an analysis of the nutritive content of the silage has not been carried out as the present work has concentrated on the methodology under local conditions.

## Conclusion

Fish silage can be successfully produced under SE Asian conditions using a 1:1 fish:starch ratio with additives of 'ragi' and a lactic acid starter culture. The process is simple and inexpensive and this safe, intermediate technological approach to the salvaging of trash fish should be adaptable to local conditions. It has been estimated that, at present, 60 per cent of the catch in Malaysia can be classed as trash fish. Thus, it is important to develop a method for the preservation of so much essential protein which is going to waste.

## References

**Carr, J. G.** (1975) Lactics of the world unite. In: *Lactic acid bacteria in beverages and food,* (eds J. G. Carr, C. V. Cutting and G. C. Whiting), pp. 369–380. London: Academic Press.

**Dwidjoseputro, D. & Wolf, F. T.** (1970) Microbiological studies of Indonesian fermented foodstuffs. *Mycopathol. Mycol. Appl.*, **41**, 211–222.

**Hardy, R., Hobbs, G. & Mackie, I. M.** (1971) Fermented fish products. *FAO Fish Rep.* No. 100. Rome: FAO, 59 pp.

**Ko, S. D.** (1965) In: *Research in Indonesia, 1945–1965,* (ed. R. M. Soemantri), vol. II p. 209. Department Urusan Research Nasional Republik Indonesia.

**Ko, S. D.** (1972) Tapé fermentation. *Appl. Microbiol.* **23**, 976–978.

**Ley, C.** (1975) Fish silage: a good protein source for Orkney cattle. *Farmers' Wkly.*, **83** (25), 34.

**Mheen, T. I.** (1972) In: *Waste recovery by micro-organisms,* (ed. W. R. Stanton), UNESCO/ICRO Work Study, p. 91. Dewan Bahasa dan Pustaka, Kuala Lumpur, Malaysia.

**Nilsson, R.** (1969) Lecture in Brunswick

**Nilsson, C., Nilsson, P. E. & Abrahamsson, A.** (1956) Origin of spores of anaerobic micro-organisms in milk. The influence of feeding practice and hygienic arrangements. *Arch. Mikrobiol.*, **25**, 1–9.

**Nilsson, R. & Rydin, C.** (1963) Fermentation as a means of preserving organic material. *Acta Chem. Scand.*, **17**, 173–179.

**Pederson, C. S. & Albury, M. N.** (1969) The sauerkraut fermentation. *Bull. New York State Agric. Exp. Stn.* No. 824, 84 pp.

**Susono, S., Gandjar, I., Basuki, T. & Karsono, H.** (1974) *Ann. Bogor.*, **5** (4), 187.

**Tatterston, I. N. & Windsor, M. L.** (1974) Fish silage. *J. Sci. Food Agric.*, **25**, 369–379.

**Van Veen, A. G. & Steinkraus, K. H.** (1970) Nutritive value and wholesomeness of fermented foods. *J. Agric. Food Chem.*, **18** (4), 576–578.

**Von Hofsten, B. & Wirahadikusumah, S.** (1972) In: *Waste recovery by micro-organisms,* (ed. W. R. Stanton), UNESCO/ICRO Work Study, p. 63. Dewan Bahasa dan Pustaka, Kuala Lumpur, Malaysia.

**Wirahadikusumah, S.** (1968) *Lantbrukshoegskolans Annaler,* **34**, 551.

# Le nuoc-mam: une providence pour les pays en voie de développement*

**A. Faubeau**

Fabrique Ivoirienne de Nuoc Mam (FINUMA), Côte d'Ivoire

**Summary**

The history of nuoc-mam production in Asia is reviewed and its origins discussed. The nutritional value of this source of protein is stressed and it is put forward as a possible solution to malnutrition in Africa. Particular reference is made to the establishment of a factory for the production of nuoc-mam in the Ivory Coast. The value of the product from the factory is discussed and the way it fits into the food regime in the Ivory Coast is explained.

**Résumé**

L'origine et l'histoire de la production de nuoc-mam sont passés en revue. Le valeur nutritionelle de cette source de protéine comme solution possible à la problème de sous-alimentation en Afrique sont accentuées. L'etablissement d'une usine pour la fabrication de nuoc-mam à la Côte d'Ivoire, la valeur du produit, et son role dans le régime d'alimentation à la Côte d'Ivoire sont décrits.

**Resumen**

Se revisa la historia de la producción de nuoc-mam en Asia y se discuten sus orígenes. Se subraya el valor nutritivo de esta fuente de proteínas y se propone como posible solución para el problema de la desnutrición en Africa. Se hace referencia de modo especial al establecimiento de una factoría para producción de nuoc-mam en Costa de Marfil. Se discute el valor del producto procedente de la fábrica y se explica la forma en que encaja en el régimen alimenticio de Costa de Marfil.

## Introduction

Le nuoc mam est une sauce au poisson produite en grandes quantités au Vietnam. D'après Doam Bich (1967) la commerce en nuoc mam avant la dernière guerre mondiale revint à 1500 million piastres. Bien que cette quantité s'est maintenant réduit, il existe encore une production cosidérable en Asie du Sud-Ouest.

D'après Guillerm et Vialard-Goudou (1953), nuoc mam est le produit de 'la protéolyse du poisson frais en solution du sel de mer concentrée, la protéolyse s'est effectuée par les enzymes du système digestif (du poisson) et des bactéries anaérobies. Pendant la dégradation protéique, des composés sont formés, qui donnent au produit son arôme et ses propriétés appétisantes qui sont très appréciées par les Vietnamois.' Donc le nuoc mam consiste en la protéine du poisson dégradée préservée par conséquence de la teneur élevée en sel. Le produit, un liquide salé, ambré, à l'arôme fort, s'en sert principalement comme assaisonnement pour les comestibles autrement sans saveur, tel que le riz.

On connait très peu sur les origines du nuoc-mam. Des recherches ont donné à penser que celles ci pourraient être Japonaises, pourtant, le nuoc-mam est très différent aux produits Japonais fermentés. Il est peu probable aussi, que la technique avait ses origines à la Chine.

Il y a une ressemblance marquée entre le nuoc-mam et 'Garum' ou 'Garon' de la région Meditérranée, et on a postulé que le nuoc-mam et d'autres produits fermentés de l'Asie du Sud-Ouest, furent introduits par des voyageurs qui s'étaient accoutumés à l'usage de 'Garum' comme assaisonnement (Grimald et Monod, 1952).

## Valeur nutritive du nuoc-mam

Puisque le nuoc-mam s'en sert en général comme assaisonnement pour les plats d'une base du riz, les quantités qui sont consommées chaque jour sont peu élevées. Néanmoins, la protéine animale étant souvent rare en Asie du Sud-Ouest, le nuoc-mam s'en sert comme contribution importante à la régime.

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*An English translation of this paper is available from TPI.

Les niveaux actuels de la consommation sont difficile à déterminer, mais à la Chine, on a estimé une consommation minimum de 40g par jour pour les adultes (12 à 15 litres par an). Donc la quantité d'azote ingérée par jour, s'éleve au peu près à 0,6g par jour, ou 7,5% des besoins. Cette proportion s'augmente à 12,5% chez les groupes socials moins privilégiés où le poisson est rare et la nourriture se fonde essentiellement sur le riz. Heureusement, le prix du nuoc-mam est suffisamment bas pour qu'il soit à la portée du même les groupes possédant les salaires les plus bas.

Blass et Richard (1952) en analysant la composition des acides aminés du nuoc-mam ont trouvé qu'il contient des quantités suffisantes des neuf acides aminés essentielles sauf de la histidine. La sauce au poisson contient aussi des quantités élevées des sels minéraux, tels que le chlorure de sodium (240 a 280 g/l), le phosphore (300 mg/l), le calcium (350 mg/l), et le soufre (à peu près 2 g/l). Par conséquence, quoique la consommation de nuoc-mam est relativement peu élevée, elle possède une valeur nutritionelle importante dans la plupart de l'Asie du Sud-Ouest.

## Le nuoc-mam en Afrique

En Afrique aussi, il y a des problèmes nutritionelles où les régimes de base consistent en des céréales qui ne sont pas seulement sans goût, mais qui manquent aussi certaines acides aminés, par exemple, la lysine. Nuoc-mam possède une teneur relativement élevée en lysine, mais une teneur peu élevée en phénylalanine. Donc le nuoc-mam et les céréales sont complémentaires, ayant comme résultat, la production de nuoc-mam à la Côte d'Ivoire.

En 1968 une organisation connue sous le nom de FINUMA, entreprenait la première production industrielle au monde du nuoc-mam. Le procès traditionel, en consiste essentiellement de l'altération par l'autolyse du poisson salé à donner un liquide brunâtre, ce procès dure à peu près un an. Le procès développé à la Côte d'Ivoire comprend la chauffage, permettant la fabrication d'un produit acceptable avec un délai de moins de 3 mois. La qualité du produit est comparable à celle du nuoc-mam Vietnamois, et les analyses chimiques et microbiologiques ont été satisfaisantes. Des régimes de base tels que les ignames ou le riz cuit sont supplémentés avec nuoc-mam à donner des repas plus agréables au goût, et plus nutritionelles, fortifiés avec des acides aminés et des sels minéraux. Des essais avec nuoc-mam aux hôpitaux et aux situations villageoises ont montré que le produit augmente le taux de la croissance des enfants affligés par le kwashiorkor (une maladie résultant d'une manque de protéines).

## Conclusions

Nuoc-mam, un produit traditionel à l'Asie du Sud-Ouest a été introduit en Afrique comme moyen de conserver le poisson et de fournir une source importante de protéine dans la régime. Ce produit est susceptible d'être fabriqué au prix bas pour la distribution même aux groupes possédant des salaires les plus bas. Il existent beaucoup d'autres situations où cette technique pourrait être introduite.

## BIBLIOGRAPHIE SELECTIONNEE DE NUOC-MAM

**Aldrin, J. F., Briand, Y., Verger, B. & Faubeau, A.** (1969) *Etudes sur les nuoc-mam de poissons de mer en Côte d'Ivoire.* Paris: Vigot Frères, Editeurs.

**Autret, M. & Vialard-Goudou, A.** (1939) Les acides aminés du nuoc-mam. 1. Le tryptophane dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient,* **17**, 1031–1038.

**Blass, J.** (1952) Etude du nuoc-mam par microchromatographie. *Ann. Inst. Pasteur* **83**, 791–799.

**Boez, L. & Guillerm, J.** (1930a) Le facteur microbien dans la fabrication de la saumure indochinoise (nuoc-mam). *C. R. Hebd. Séances Acad. Sci.,* 190, 534.

**Boez, L. & Guillerm, J.** (1930b) Pouvoir proteolytique de la flore anaerobie de la saumure indochinoise (nuoc-mam). *C. R. Soc. Biol.* 103, 1054.

**Cousin, E. & Dang-Vu-Kha** (1944) Les infiniments petits chimiques du nuoc-mam. Sur la mise en évidence et le dosage de l'arsenic. *Rev. Méd. Fr. Extrême-Orient,* **22**, 413–414.

**Cousin, E. & Nguyen-Van-Dinh** (1941) Note de laboratoire sur la recherche de l'allantoine dans le nuoc-man. *Rev. Méd. Fr. Extrême-Orient,* **19**, 986.

**Cousin, E. & Nguyen-Van-Dinh** (1943a) Note de laboratoire sur l'absence de sulfocyanures dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient,* **21**, 766–767.

**Cousin, E. & Nguyen-Van-Dinh** (1943b) Sur l'absence d'acides biliaires dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient,* **21**, 768–769.

**Cousin, E. & Nguyen-Van-Dinh** (1944a) Note de laboratoire sur la recherche des pigments biliaires dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient,* **22**, 213–214

**Cousin, E. & Nguyen-Van-Dinh** (1944b) Le brome et l'iode du nuoc-mam. *Rev. Méd. Fr. Extrême-Orient,* **22**, 408–412.

**Cousin, E. & Nguyen-Van-Dinh** (1944c) Note de laboratoire sur la recherche de l'acide formique et de l'alcool méthylique dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient,* **22**, 738.

**Cousin, E. Nguyen-Van-Dinh & Dang-Vu-Kha** (1943) Le soufre de quelques milieux biologiques. *Rev. Méd. Fr. Extrême-Orient,* **21**, 721–737.

**Cousin, E. & Noyer, B.** (1944) Mise en évidence et dosage biologique de l'histamine dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient*, **22**, 382–390.

**Crimald, P. & Monod, Th.** (1952) Sur la véritable nature du Carum. *Rev. Etud. Anc.*, **54**, 27.

**Dang-Vu-Kha** (1941) Corps cétoniques et cétogènes dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient*, **19**, 377–380.

**Doam Bich, R.** (1967) *Vietnam d'Aujourd'hui*, May/June.

**Frontier-Abou, D.** Note préliminaire sur un essai de fabrication artisanale de Nuoc-Mam à partir des résidus de l'industrie crevettière. Orstom Nosy-Be, Decembre 1973.

**Guillerm, J.** (1928) Le nuoc-mam et l'industrie saumurière en Indochine. *Arch. Inst. Pasteur Indochine*, No. 7, 21.

**Guillerm, J.** (1930) L'exploitation scientifique d'un phenomene empirique: la production du nuoc-mam. *C. R. 8eme Congr. F.E.A.T.M. Bangkok*, **1**, 122.

**Guillerm, J. & Vialard-Goudou, A.** (1953) Fabrication, définition et réglementation de la sauce de poisson vietnamienne nuoc-mam. *Proc. 8th Pac. Sci. Congr.*, **3**, 208–214.

**Hamm, W. S. & Clague, J. A.** (1950) Temperature and salt purity effects on the manufacture of fish paste and sauce. *Fish and Wildlife Service, US Dep. Int. Res. Rep.* No. 24.

**Krempf, A.** (1929) Traitement industriel des produits de la pêche. *Rapp. Fonct. Inst. Ocean. Indochine*, 1928–1929, 13e note, pp. 40–43.

**Legroux, R., & Levaditi, J. C., Bovet, D.** (1946) Présence d'histamine dans du nuoc-mam conservé au laboratoire. *C. R. Soc. Biol.* **140**, 864–866.

**Ngo-Bá-Thanh** (1953) Un condiment azote. Le nuoc-mam. Thèse de Doctorat de Medecine Veterinaire, Lyon.

**Nguyen-An-Cu & Vialard-Goudou, A.** (1953) Sur la nature de l'acidité volatile de la saumure vietnamienne 'nuoc-mam'. *C. R.* **236**, 2128–2130.

**Nguyen-Van-Dinh** (1941) La créatinine dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient*, **19**, 981–985.

**Nguyen-Van-Dinh** (1944) Note de laboratoire sur la recherche de l'alcool et des aldéhydes dans le nuoc-mam. *Rev. Méd. Fr. Extrême-Orient*, **22**, 345–347.

**Paulmier, M.** (1971) *Rapport sur les malnutritions et dénutritions chez les enfants de la Region de Man. Etude préliminaire: intérêt du nuoc-mam.* Ministère de la Santé Publique et de la Population, Direction de la Médecine Sociale, Abidjan.

**Peirier & Nguyen-Kim-Kinh** (1933) Dosage rapide des acides aminés et des polypeptides dans le nuoc-mam. *Ann. Falsif. Fraudes*, **26**, 6.

**Riviere, R.** (avec la collaboration de **Dubroca, G.**) Etude sur la compostion du Nuoc-Mam de Côte d'Ivoire Paris: Vigot Freres Editeurs.

**Rose, E.** (1918) Recherche sur la fabrication et la composition chimique du nuoc-mam. *Bull. Econ. Indochine*, **129**, 155.

**Rose, E. & Mesnard, J.** (1920) Recherches complémentaires sur la fabrication du nuoc-mam. *Ann. Inst. Pasteur*, **34**, 622.

**Truond-Van-Chom.** (1954) Contribution a l'étude du nuoc-mam. Thèse de Doctorat de Pharmacie, Marseille.

**Van Veen, A. G.** (1941) On volatile aromatic substances from certain fish products. *Natuurw. Tijdschr. Ned.-Indië*, **101**, 147–148.

**Vialard-Goudou, A.** (1941a) Les composants minéraux de la saumure Indochinoise 'nuoc-mam'. II. Calcium, magnésium et fer. *Rev. Méd. Fr. Extrême-Orient*, **19**, 588–594.

**Vialard-Goudou, A.** (1941b). Teneur en bases volatiles et en acides volatils de la saumure Indochinoise 'nuoc-mam'. *Rev. Méd. Fr. Extrême-Orient*, **19**, 1061–1071.

**Vialard-Goudou, A.** (1942a). Etude chimique de la saumure Indochinoise 'nuoc-mam'. Recherche et dosage de l'indol et des corps indologènes. *Rev. Méd. Fr. Extrême-Orient*, **20**, 853–858.

**Vialard-Goudou, A.** (1942b). Etude chimique de la saumure Indochinoise 'nuoc-mam'. Les acides aminés, dosage de la tyrosine totale. *Rev. Méd. Fr. Extrême--Orient*, **20**, 859–876.

**Vialard-Goudou, A.** (1942c) Etude chimique de la saumure Indochinoise 'nuoc-mam'. Recherches et caractérisation de quelques produits de dégradation: acide butyrique, acide lactique, dérivés de l'imidazol (histamine) et tyramine. *Rev. Méd. Fr. Extrême-Orient*, **20**, 960–963.

**Vialard-Goudou, A.** (1943) Etude chimique de la saumure Indochinoise 'nuoc-mam'. Recherche et dosage de l'acide indol $\beta$ acetique. *Rev. Méd. Fr. Extrême-Orient*, **21**, 879–887.

**Vialard-Goudou, A. & Dang-Van-Tien** (1940) Les composants minéraux du nuoc-mam. I. Soufre minéral et soufre organique. *Rev. Méd. Fr. Extrême-Orient*, **18**, 547–552.

**Violle, H. & Rose, E. R.** (1933) De l'inactivité de nuoc-mam dans le beriberi expérimental. *C.R. Soc. Biol.*, **114**, 255.

**Bremond, H. M. L.** (1919) Recherches sur quelques condiments azotés d'Extrême Orient. Thèse de Doctorat de Pharmacie, Bordeaux.

# The utilization of by-catch in shrimp fisheries

**W. H. L. Allsopp**
International Development Research Centre, Canada

### Summary

The paper draws attention to the change in policy and attitude with regard to the processing of industrial fish from fish which can be consumed directly. Less developed countries have placed greater emphasis on self-sufficiency in food. An area of special concern is the waste from the by-catch of shrimp trawlers, operating off tropical coasts, where the total catch of edible fish jettisoned at sea is estimated at five million tons annually. It is explained that the current design and operating system of shrimp trawlers leave little alternative since the profitability of handling fish as well as shrimp is unattractive. Technological solutions are discussed and experiences in Guyana and SE Asia are cited. Since the areas of greatest need are in tropical countries, it is urged that a concerted effort be made on this particular problem.

### Résumé

Cette communication attire l'attention sur le changement de politique et d'attitude en ce qui concerne le traitement du poisson industriel à partir de poisson qui peut être consommé directement. Les pays en voie de développement accordent une plus grande importance à leur indépendance en matière alimentaire. Un intérêt spécial revient aux déchets provenant des prises secondaires des chalutiers pêchant la crevette au large des côtes tropicales où les prises totales de poissons comestibles rejetés à la mer sont estimées à cinq millions de tonnes par an. Il est expliqué que le type et le système de fonctionnement actuels des chalutiers pêchant la crevette laissent peu de choix étant donné que la rentabilité du traitement du poisson comme de la crevette est faible. Des solutions technologiques sont discutées et les expériences réalisées en Guyane et en Asie du Sud-Est sont citées. Etant donné que les zones de plus grand besoin se trouvent dans les régions tropicales, il est recommandé qu'un effort concerté soit fait sur ce problème particulier.

### Resumen

El artículo llama la atención sobre el cambio de política y actitud con respecto a la elaboración industrial del pescado que también puede utilizarse para el consumo en fresco. Los países menos desarrollados han dedicado la máxima atención al autoabastecimiento alimentario. Un aspecto de especial importancia es el desperdicio de los subproductos de la pesca de gambas en los barcos de arrastre que operan en costas tropicales, donde la cantidad total de pescado comestible capturado que se devuelve al mar se estima en cinco millones de toneladas anuales. Se explica que el diseño y el sistema operativo actuales de los barcos rastreadores de gambas apenas dejan otra alternativa, ya que la rentabilidad del manejo del pescado al mismo tiempo que las gambas es poco atractiva. Se discuten soluciones tecnológicas, y se citan experiencias en Guayana y en el Sureste de Asia. Puesto que las zonas más necesitadas están en países tropicales, es urgente que se realice un esfuerzo coordinado en este problema particular.

### Introduction

The impending world food and population situation has made it imperative that the most effective use of all available fish resources suitable for human consumption be carefully reviewed. The maximum benefits must be derived particularly in tropical areas, where there is an animal protein deficiency in the food consumed. Many developing countries have expressed concern that mechanized fishing off their shores removes large quantities of fish which are destined (whether as fish meal or quality products) for the more developed and much richer countries, where there is no animal protein malnutrition or even food shortage. Such fish do not enter into the economy of the coastal countries. The historical attitude towards fish meal for livestock feeds and the current practices in tropical waters of converting edible fish into fish meal should be reappraised. Positive, forward-looking attitudes towards the gainful use of these fish are essential to satisfy future human survival needs since fishing for food fish is, in comparative terms, declining.

In developing countries, the opinion that rapid industrial development of fisheries can best be established through fish meal production and other export products such as lobster, shrimp and tuna, is gradually giving way to the need for the industry to focus on domestic self-sufficiency in food. Higher import costs of food, inflationary costs of imported machinery, and the law of the sea portents and considerations have contributed further to the need to develop self-sufficiency. As a result, the value and importance of fish, as a source of protein, have increased. Their presentation as a highly acceptable (and hygienic) product suitable for human consumption, is essential. Transformation into more acceptable products can be effected through the use of improved processing equipment such as the meat/bone separator.

The shrimp trawling by-catch is a fish resource which offers an opportunity for food supply from tropical sea areas adjacent to countries whose populations are short of fish supplies. Wherever large tropical rivers deposit an alluvial outflow, which enriches the bottom-feed organisms on a broad continental shelf outspread, the occurrence of large shrimp (sometimes called prawns) has given rise to shrimp trawling enterprises. For over thirty years, these shrimp fisheries have been generally exploited by the 'Gulf of Mexico' type of shrimp trawlers. These vessels, which are mainly owned by American and Japanese companies, have been designed to cater exclusively for the shrimp caught. However, large quantities of fish are caught incidentally in the fishing operation and this 'by-catch' is discarded at sea, or, in a few cases, converted to animal feeds.

Joint ventures and international shrimp trawling companies now fish in the Gulf of Mexico, off South America, East and West Africa, Madagascar, the Indian coasts and in the SE Asian seas. It has been estimated that the fish by-catch may total an annual average of five million tons of fish which are jettisoned in the tropical seas of the world while one million tons of shrimp are landed world-wide. A solution is therefore urgently needed to this problem so that more of the products harvested from the seas may be consumed and conserved by the populations of less privileged tropical coastal communities in the world's poorer countries.

## The problems

Since it is difficult for many people to accept that such fantastic wastage occurs, the complexity of the problem should be clearly explained. The shrimp vessels are designed with a refrigerated hold capacity of 15 to 30 tons of shrimp. They have a crew of four or five, are highly powered (450 HP engines) and costly to operate. The capital cost of vessels varied from US $150,000 to $300,000; operating costs and crew payments depend on their catch, efficiency and location. The vessels operating off Guyana generally made gross annual earnings from the shrimp catch equivalent to the initial investment on the vessel. This can be done (with resulting profits to owners and crew) only if the hold is filled with shrimp, not fish! Various factors such as the temperature of the hold, number of the crew and the time at sea are important specifically for handling shrimp. Furthermore, the great bulk of, and the variation in, the fish that are caught make it impractical to accommodate the total by-catch within the present system. The value of this fish (approximately US 10 cents/lb) compares adversely with shrimp (at least US $1/lb). The fish are therefore thrown overboard!

The problem is not only economic but also technological. In tropical seas the number of fish species caught in a trawl may be at least 20 and more generally 50. They are variable in size and chemical content (white or oily) and, among the mixture, some fish may be poisonous. The quantity of fish caught will vary with the place (bottom type, depth and currents), time of day (fish are generally more active in daylight than shrimp) and time of year (the rainy seasons cause outflows from distant estuaries which affect the availability of fish). Generally the weight of shrimp caught varies between 10 and 30% of the total trawl. The bulk of edible fish is thus at least three to nine times the amount of shrimp caught. As some species of fish become mature and gravid the chemical composition of the flesh and even its palatability varies. This mixed bag would be difficult to process, even by reduction, without some sorting into oily and white fish types. There is, however, insufficient time between landings for the crew, who are few in number, to sort the bulk of the fish. The operation is nocturnal.

For all practical purposes and for operational efficiency, only the major quantities of acceptable market fish can be considered for collection aboard or processing ashore. Also, their availability must be assessed before industrial-scale processing can be considered. When assessments were made for the Guyanan shelf it was estimated that there were approximately 200,000 tons of consumable fish, involving eight major 'white flesh' types, which could be obtained annually from the fleet of between 175 and 210 trawlers. In comparison, the countries of the Caribbean import the equivalent of 150,000 tons of fresh fish annually. To test the practicality of using this fish, each trawler arriving at the port of Georgetown was required to land the last few days' catch of marketable fish. These fish, totalling approximately 2400 tons per year, were to be converted into fish products which, had been traditionally imported, ie salted and smoked fish. In addition, fresh fish sales were increased. However, the sudden volume of fish brought into the market circuit created problems in their handling, processing, cold storage and sales/distribution. This large through-put from trawl landings is not easy to accommodate in a tropical country unless an efficient industrial infrastructure for handling fresh or iced fish exists. With fish spoilage and wastage, a spirit of frustrating discouragement is fed back both to the shore handlers and to the fishermen who bring in the by-catch.

Additional products are being prepared from these mixed species by using the flesh obtained from meat/bone separators. It is planned that these comminuted fish products will form the basis of a new series of products to use the bulk of fish caught as the trawler by-catch. The mixed fish flesh will not be readily identifiable as to species and will form a new material from which hygienic edible products, both low-value and speciality types, are made.

At the IDRC workshop held in Thailand in 1974, similar situations in SE Asia were described. A parallel approach was being made through the fish technology laboratories in India, the Gulf of Thailand and Indonesia to solve the problem of the wastage of the by-catch. It was pointed out that, without any increase in fishing effort, more than one million tons of by-catch can be thus available from shrimp vessels trawling in that area.

### Factors contributing to a solution

Since it is generally accepted that such a waste of consumable fish is unacceptable, solutions for its satisfactory use are being sought throughout the tropical world. These approaches are: considering ways of handling the fish at sea; systems for collecting and transportation from shrimp trawlers; and the processing of a mixed bag of species.

The development of shrimp/fish separator trawls had given promise that this could facilitate the sorting of fish at sea. Alternatives included the use of detached floating cod-ends and/or refrigerated sea-water (RSW) tanks, on the deck of trawlers, into which the day's catch can be held. For both systems the catch must be collected by a vessel, operating with the fleet of conventional trawling vessels, and landed weekly. The collection vessel requires large (but inexpensive) refrigeration systems for storing the fish during transport to the port. The vessels with the RSW system used by the Pacific herring fleet in British Columbia are considered sufficiently adaptable for the exercise. However, until the bulk handling of the by-catch is proved to be practical and efficient at a low cost, industrial-scale processing ashore will not be readily applicable since the landed costs of the fish will be too high, before processing, for low-income consumers (the target population).

Experimental processing of the mixed bag of fish using deboning machines provided an extruded flesh totally free of bones, scales and skin. The waste can be converted to fish meal while the comminuted fish flesh is now a new raw material, comprising various species of fish which cannot be visually identified by the consumer. Tests have been conducted in the IDRC project in Guyana using the comminuted flesh to make dried, spiced or salted products which are stable at normal temperatures, can be packaged in sealed plastic bags and sold at low cost. Additionally, the project plans to make products of higher market value. That portion of the catch which comprises fish of high consumer demand (species or size) is to be processed as fillets or speciality products. The higher value products are intended to contribute appreciably to the processing costs. This permits the bulk preparation of stable fish products at a low price for the rural and remote communities where electricity and refrigerated household or market storage are not widely available.

It is noteworthy that products using comminuted flesh have also been made in three laboratories in India, Thailand and Indonesia and it is urged that industrial-scale enterprise should further develop their pilot operations using locally designed machines. The products have a ready market acceptance.

### Areas of greatest need

The often published figures of fish production and the gap in protein requirements of the tropical belt of the developing world emphasize the imposed obligation to utilize such incidental catches of fish, not as fish meal, livestock feeds or pet foods but as comestible fish products for direct human needs. The catches off the western coasts of Africa and South America have been converted by 'fish protein seekers' into fish meal. This should be discouraged for the shrimp trawling by-catch.

The world population increase is posing an unparalleled food dilemma for the 21st century. While the world's fish production has increased from 33.3 million tons in 1958 to 66 million tons in 1973 (doubling in 15 years), there has been a decline in the direct consumption of fish from 84% of the landed catch to 60%, with a comparable rise in the industrial processing (for fish meal etc) from 16% to 40% of the total catch.

This means that the current trend is to convert to fish meal almost the equivalent quantity of fish (26.2 million tons) as was directly consumed by man (28 million tons) 15 years ago. The agonizing corollary of this is that the increased catch, which has been converted into fish meal and sold for feeding the livestock of the affluent nations of the world (ie North America and eastern and western Europe), has largely come from the oceans (off Africa and South America) adjacent to protein deficient countries.

There is concern that the implications of the law of the sea will limit the fish production available to the traditional and powerful high-seas fishing nations of the world. The grave concern of the developing world is the higher cost of technology, manufactured goods, services and fuel. The new focus of their attention is self-sufficiency in food, maximum home grown production, minimal waste and adequate employment. With these imperatives in the less developed world a more humane perspective is required by advanced technology of the developed world. This should concentrate on areas such as the by-catch from tropical shrimp trawling to be used as hygienic food for man.

It is urged that fish meal and industrial fish products should be made only from fish which are not otherwise caught or are not suitable for human consumption and from offal or trimmings from plant wastes. Fish species which have direct consumer acceptance should not, on moral grounds, be used for reduction since protein requirements for livestock will be provided by other means.

It is submitted that this Conference give some serious attention to this problem which, by its solution, can bring into circulation an additional estimated five million tons of edible fish in the less developed areas of the tropical world now, and in the 21st century. A comprehensive review, with detailed references is being prepared on this subject.

**Note**: World production figures are based upon FAO's fishery statistics yearbooks.

# A note on salt minced fish

E. G. Bligh
nvironment Canada, Canada

The increasing domestic and international demand for a noderately priced, stable fishery product, with good utritional value and acceptance, has induced continuing nvestigations at the Halifax Laboratory. Fish protein oncentrate prepared by the Halifax process and, later, he patented functional fish protein have resulted from his work. However, these processes require rather ophisticated operations which are not currently conomic. The preparation of a salted product from nechanically deboned minced fish presents an opporunity to overcome some of these problems.

Canada, along with the rest of the world, has entered a eriod of fish scarcity at a time when it is hoped that he oceans can provide a greater proportion of man's ood in the decades ahead. Therefore, through the evelopment and demonstration of new technology, we re endeavouring to make more products available for uman consumption without necessarily increasing our ish landings. This means that we must utilize existing atches more effectively and develop processes whereby nder-utilized species and materials can be converted nto seafoods. Minced fish appears to be a technological reakthrough, which offers tremendous potential and pportunity in this field but, at the moment, market emand is low due principally to the lack of product orms which have consumer appeal.

n recent months, as part of our minced fish programme t the Halifax Laboratory, we have been emphasizing vork on a salted minced fish product. Some of the easons for this are:

- texture deterioration is a problem with frozen minced fish products
- traditional production of salt fish is declining while market demand and prices remain constant
- the salting process is simple, inexpensive, and uses readily available processing equipment and raw materials
- there is a world demand for a stable fish product with high nutritional value
- many developing countries are interested in this type of technology
- the product is expected to find acceptance in domestic and foreign markets.

The salting of deboned (minced) lean fish muscle is very quick and simple. In principle, the process does not differ from the traditional method of salting whole or split fish except that, with minced flesh, the penetration of salt is much more rapid and uniform and can be better controlled. Essentially the steps in preparing salt minced fish from fresh lean fish are as follows:

(1) *Cleaning the fish:* removal of heads and viscera, followed by washing; in large fish, it may be desirable to remove the backbone.

(2) *Separation:* mechanical separation of flesh from bones and skin by means of a commercial deboning machine.

(3) *Addition of salt:* sufficient fine salt is mixed with the minced flesh to saturate all the water which is present in the tissue.

(4) *Brine formation:* the mixture is held for a few minutes at a slightly elevated temperature, the salt is dissolved by the water, the protein is denatured and loses its water binding capacity and water is released from the solids forming a saturated brine.

(5) *Brine removal:* the released water, which is saturated with salt, is removed by pressing or centrifugation; the brine also contains some soluble components including blood pigments.

(6) *Product formation:* the light coloured press cake may be shredded, formed into cakes etc; it has neutral odour and flavour and contains approximately 42% water, 26% salt, 32% protein.

(7) *Drying:* 20% moisture (35% salt, 45% protein) will prevent the growth of halophilic bacteria and permit storage at 35°C for extended periods.

(8) *Packaging:* the product must be protected from light (causes discolouration), air (causes rancidity) and moisture to retain acceptable qualities for extended storage periods.

(9) *Storage:* some ageing of the product is required to develop a characteristic salt fish odour and flavour; estimated storage life at 35°C of the dried product is approximately one year.

The entire process can be completed within a day although it is possible to hold the material for several days once step 4 is completed. The product from steps

5 or 6 is also fairly stable but it will spoil within a few weeks if it is not protected from air and/or high temperatures. As indicated above, the few kinds of red bacteria and moulds, which spoil traditional salt fish, can grow on the material that has not been dried.

As with salted fish, salt minced fish must be soaked in water to reduce the salt content prior to consumption. However, since the product is fibrous, soaking in cold water for a few minutes, with occasional stirring, is sufficient to effect desalting and rehydration. Consumers must be cautioned that the rehydrated product is susceptible to spoilage and that it must be handled and stored in the same way as fresh fish.

Although many of the factors important in making salt minced fish have been studied, there are other areas that are still being investigated. For example, whether the process can be applied to fatty or semi-fatty species of fish or whether the growth of halophiles can be prevented, without drying, through the use of inhibitors such as sorbic acid. Nevertheless, due to the general interest in this type of product, a collaborative project is in progress with the World Food Programme; six tons of the product will be evaluated in feeding trials in ten different countries. The test product is being made from Atlantic cod and the dried material is packaged in 0.5 kg laminated pouches. The potential of salt minced fish in the traditional markets for Canadian salt fish will also be examined since it is expected that the product will be produced commercially in the very near future. Within the next few months, we should have a better understanding of the short-comings and potential of this product concept. Also, it is hoped that the further studies which are continuing will help to allow broader raw material selection, simpler processing and longer assured shelf life as well as a more economical and acceptable product.

In summary, salt minced fish has many attractive features in that a simple and inexpensive process can be used to convert under-utilized fish and fish materials into a seafood with high nutritional value and an extended shelf life at ambient temperatures. The salting process is employed to facilitate the removal of water from fish muscle, thereby reducing time and/or energy requirements for drying, and serves to preserve the product as well. The product and the process technology can be readily transferred to developing nations to help overcome requirements for animal protein and provide an effective means of processing available fishery resources.

# Discussion

In this session there were two discussion periods, one after the presentation papers and one after the moderator's review.

## Papers 1, 2 and 3

The high level of interest in fish meal and other types of 'fish concentrates' was reflected by the number of contributors to this discussion. Problems likely to be encountered in their production, particularly in relation to the tropical situation, were highlighted. These included fat extraction to levels below 10%, recovery of stickwater, odour production, antioxidant addition and other storage problems. The preparation of fish silage was considered for situations where fishmeal production is uneconomical; its uses and possible disadvantages were also discussed.

After the second presentation paper, **R. H. James** was asked to outline work in the Solomon Islands designed to utilize tuna waste from the local tuna cannery, by a process similar to one described in the paper by **Disney, Tatterson and Olley**. Preliminary trials showed that cooked material (excluding heads and guts) was preferable to the raw material (or a combination of the two) for making an animal feed preserved by formic acid. The results of pig feeding trials were most encouraging and pilot-scale trials are now under way. It is hoped that commercial production will soon commence.

In opening the more general discussion, the possibility of exporting high fat content meals was raised by **Mattos**, who mentioned that, in Uruguay, fish meal with 18–20% fat and of high nutritional value has created no problems. **Barlow** pointed out that this could not be sold on the international market since the standard is set at 10% fat. Moreover, tainting may be a problem if high fat content meals are incorporated into finisher rations.

In response to **Lima dos Santos'** query on stickwater concentration, **Barlow** replied that he was not familiar with the situation in many tropical countries but, in Peru, they do now use the stickwater; this not only prevents wastage of valuable protein but also reduces pollution. **Primo** mentioned that some factories do sometimes use the stickwater. It was pointed out by **Petersen** that stickwater contains 15–20% of the total protein and it is therefore uneconomic (and in some countries forbidden) to discharge it into the sea. He added that for concentrators to work efficiently, their heating surfaces must be thoroughly and regularly cleaned to remove protein and mineral deposits. **Rottwitt Schmidt** then commented that a new market, as yet not very large, is emerging for spray-dried stickwater.

Several problems likely to be encountered in the production of fish meal in developing countries were outlined by **Camacho**. He felt that the principal problem is the supply of the raw material but other problem areas are packaging, marketing and storage. Imported packaging materials are expensive, as are freight and insurance rates. There is also a shortage of shipping space in some areas and the product may have to be stored for long periods under unfavourable tropical conditions. Furthermore, unless the fish meal is kept in a well-designed store, insect infestation is likely to cause serious problems.

The next question was from **Iyer** on the use of ethoxyquin in fish meal. **Barlow** replied that is permitted in the EEC. Later on in the discussion **Talabi** commented on the difficulties of uniform application of ethoxyquin; **Karnicki** mentioned that ethoxyquin sprayers are available for use in large fishmeal plants and his Institute has developed a sprayer for use in small plants (5–25 tons/day). He added that a UK firm produces a special sensor which regulates the dosage of antioxidant according to the fat content of the meal; this is particularly useful for situations where the fat content of the meal produced in a day varies widely, eg on board fishing vessels.

A short discussion followed **Barker's** question on the prevention of odours produced during fishmeal manufacture. **Barlow** pointed out that the offensive odours are from the dryer and these can be reduced by incinerating the exhaust gases through the main boiler. **Disney** and **Herborg** added that the raw material itself often poses 'odour' problems; it is essential to keep the fish as fresh as possible and to keep the fish reception area clean.

**Bonsu**, referring to the comment in the **Barlow** paper that potentially toxic fish should be tested on animals before incorporation into fish meal, asked if there are any chemical or physical methods for testing fish toxicity. In reply, **Barlow** mentioned that rats are used for screening purposes; he was not aware of any reliable chemical tests.

The remainder of the discussion considered the relative merits of fish silage and fish meal. The low capital investment required for silage production and the flexibility of operation were, **Disney** felt, highly relevant to many developing small-scale fisheries where fishmeal production is not commercially viable. He added that the odours associated with silage production create less of a problem than those from fishmeal manufacture. **Mattos** then suggested that meals, prepared in many tropical countries by simple cooking and sun drying (45–50% protein), may be a preferable choice to the 20% protein silage. **Disney** pointed out that carbohydrate would have to be added to the high protein meal before use (ie it is diluted); furthermore, the overall costs may well be similar.

Referring to the continuing expansion of fish culture throughout the world, **Ilyas** asked if silage can be substituted for fish meal as a feedstuff. Although unaware of current feeding trials, **Disney** pointed out that the dried product is very similar to many commercially available feeds. On this point, **Kuriyan** added that he can provide details of silage feeding trials carried out at his Institute. The recent technical conference on aquaculture held in Kyoto, Japan, was brought to the attention of the meeting by **Hjul**. Fish culture feeds were discussed and the Conference agreed that wet silage is not suitable but dried silage could have a future, particularly if incorporated into prepared feeds.

The possibility of skin irritation during silage preparation was raised by **Burt**. **Disney** commented that the use of the corrosive acids has not created any problems and it must be remembered that the final pH is around 5.0.

In reply to **Sowumni's** question on the possible cyanide problem in feeds containing cassava, **Disney** said that dried cassava had been used in three countries; the skin was removed and no problems had been experienced. He added that any cheap, readily available, dried carbohydrate would in fact be suitable as a filler.

Finally, the use of dried prawn shells as a source of chitosan for the textile industry (sizing and dye uptake) and as a water purifying agent was touched upon briefly by **Lima dos Santos** and **Kuriyan**.

### Papers reviewed by the moderator

The current interest in the prevention of waste and the need to develop products which are stable under tropical conditions is evident from the papers submitted for this session and from the liveliness of the discussion. The main theme of the discussion was on current lines of investigation into new and/or novel products, particularly those using comminuted flesh, and their significance for tropical situations.

In opening the discussion, **Bligh** briefly outlined the preparation, and highlighted some of the properties, of the Canadian salted minced product. He mentioned that the product is being evaluated in a number of tropical countries and that a brochure, with details of its preparation, is available. This report stimulated considerable interest from the floor; it generated a number of questions, prompted other delegates to describe similar work being carried out in their own countries and raised the topic of utilizing fatty species of fish.

**Bligh**, replying to **Steinberg's** question on the loss of water-soluble protein in desalting, said that most is lost during the initial salting. In response to **Barlow's** query on the raw material used, **Bligh** said that whole dressed cod was used, not offal; he felt it would not be possible to use very oily fish. **Beraquet** asked how the process differed from that described by Del Valle in 1968 and also presented at the Tokyo Conference. **Disney** offered to comment on this. He pointed out that Del Valle used extremely high pressures to form the comminuted flesh into cakes and to remove some of the moisture. He also mentioned the process developed at TPI for making salted, minced shark cakes using a simple hamburger press. **Beraquet** commented that a similar product had been developed in Brazil and was well accepted by a large group of school children in the trials recently carried out. Fatty fish, he added, were not suitable.

Then, **Clarke** and **Gordon** spoke of the current research in Guyana on salted comminuted fish. Developmental work utilizing the shrimp by-catch has progressed over the last three years; stability trials and taste panel studies have been completed successfully. The product is due to be tested on a larger scale using institutional services. Referring to his paper on fish cheese (written jointly with **Johansen**, **Herborg** said that their reason for contributing this work to the Conference was to (hopefully) establish whether this type of product is of any interest to people in developing countries. The minced fermented product is purely experimental; they want to gauge the reaction from the tropics.

From **Dhatemwa**, the meeting heard that, in Uganda, a minced *Haplochromis* and maize flour mixture has been developed but, due to its fishy smell, it has not proved to be acceptable. **Steinberg** commented that they have found the same problem with some cereals, such as wheat, which tend to accelerate oxidation; the addition of an appropriate antioxidant is therefore beneficial. He added that they have used 200 ppm tertiary butyl hydroquinone. The possibility of using another cereal, which is likely to contain an antioxidant, was suggested but **Dhatemwa** replied that maize meal was used because it is the cheapest available.

The need for outlets for the numerous species of oily fish, particularly the small ones, which are available in the tropics was stressed by **Disney**, who felt that deboning may possibly have a future for such fish. Not wanting to sound too pessimistic, **Bligh** expressed the view that the technology for producing quality seafoods from minced fatty fish is not currently available. He suggested that such fish may best be processed by traditional methods, such as salting, smoking and canning, since mincing will, he felt, present special problems particularly in tropical temperatures. Problems associated with processing fat fish relate, said **Bligh**, to their rapid spoilage and the high degree of unsaturation of the fats. In tropical climates, spoilage is extremely rapid and will have to be controlled before and during processing. **Bligh** added that, in tropical temperatures, he would expect some fat to be released from the tissue during mincing and processing. On the topic of utilizing fatty fish, **Herborg** commented that they have found a stabilizing effect by incorporating 10% soybean oil into garfish patties (fat content 6%), which were acceptable after more than one year's storage at –20°C.

Commenting on the acceptability trials reported in the **Tagle, Valand** and **James** paper, **Talabi** said that FPC type B does not compete with stockfish in Nigeria; they are completely different products with different outlets and usage. **Iyer** then asked if any work was being carried out to improve the functional properties of FPC. In reply, **Steinberg** pointed out that FPC is FPC by definition; the proteins of fish muscle can, however, be 'concentrated' by other methods, both traditional and novel (some of which are described in papers in this and the following session).

The remainder of this period was taken up with a somewhat heated discussion of fish sauce (nuoc-mam) as prepared in the Ivory Coast. After the moderator's review, **Faubeau** took the opportunity of speaking on his paper; he mentioned the enormous benefits of this product when fed to children suffering from malnutrition. **Talabi** hastened to point out that the product was fed to patients in a clinic; he felt that this was a small percentage of the population and was unrepresentative of the Ivory Coast. Furthermore, it cannot be inferred that the product would be accepted throughout Africa.

In response to **Faubeau's** comment that FAO has been antagonistic to the increased use of nuoc mam, **Krone** pointed out that this is not the case; FAO simply had no means to support the work. The reason that the World Food Programme did not include it in their programme was, he said, probably because it was not considered traditional and therefore could not be included in the 'food baskets' system used by WFP.

On a number of occasions during the discussion, **Beddowes** asked what kinds of fish and what conditions were used to prepare the nuoc-mam and how it compared with the traditional Vietnamese product. The nutritive value of nuoc-mam was further expounded by **Faubeau** but, at the end of the discussion period, the questions were still largely unanswered; the suitability of a variety of species of fish, and of offal and guts, as raw material for sauce production had, however, been stressed.

# Session 6

## Canned and other processed fish

**Thursday 8th July**
**Morning**

Chairman
E. G. Bligh
Environment Canada
Canada

Moderator
B. L. Amla
Central Food Technological
Research Institute
India

Rapporteur
A. J. Mathotho
Ministry of Agriculture
Malawi

# Fish processing and marketing in the tropics: restrictions to development

**D. G. James**
Department of Fisheries, FAO, Rome

### Summary

Some problems of handling, processing and marketing fish under tropical conditions are reviewed. Some of the losses caused by inadequate facilities for handling and transport, as well as part-processing losses, which cause wastage of product, are identified. It is apparent that these are beyond the present ability of the industry to control but suggestions for technological improvement are offered. It is, however, recognized that social factors, rather than technological limitations, will be the most difficult to overcome.

### Résumé

Certains problèmes concernant la manipulation, la préparation et la commercialisation du poisson sous les tropiques sont passés en revue. Certaines des pertes causées par des modalités inadéquates de manipulation et de transport ainsi que les pertes résultant en partie de la préparation et donnant lieu à des déchets sont analysées. Il est évident que les possibilités industrielles actuelles ne permettent pas de remédier à ces pertes, mais des suggestions sont faites pour des améliorations technologiques. Cependant, il est admis que les facteurs sociaux plus que les restrictions technologiques seront les plus difficiles à surmonter.

### Resumen

Se revisan algunos problemas de la manipulación, elaboración y comercialización del pescado en condiciones tropicales. Se han identificado algunas de las pérdidas debidas a métodos inadecuados de manipulación y transporte, así como pérdidas parciales en la elaboración que causan mermas en el producto. Está claro que estas pérdidas escapan la capacidad actual del control industrial, y se hacen sugerencias para mejoras tecnológicas. Se reconoce, no obstante, que los factores sociales serán más difíciles de superar que las limitaciones technológicas.

## Introduction

Anyone contemplating starting or intensifying a fishing industry under tropical conditions is faced with an array of complex problems. Although many of these are also felt in temperate areas, the combination of adverse conditions frequently has more impact in developing tropical countries. Circumstances throughout the tropics differ so much that it is impossible to take an overall view of the difficulties of stimulating the growth of fishery industries in developing countries. For the purposes of this paper, consideration is largely restricted to the problems experienced in small-scale or village-level fisheries where many points of similarity can be seen.

Compared with the amount of effort which has been put into research and development for fisheries in the cool waters of the northern hemisphere, very little has been undertaken in tropical areas. Much more work is required to understand the differences in behaviour of warm water (tropical) species during storage and the conditions which are associated with their capture and distribution. Although experience accumulated in other areas makes it possible to offer technological solutions to many of the problems, closer study immediately shows that they are almost bound to fail. This is not because the technology is faulty but, due to social and economic conditions, many of the developing countries in the tropical world cannot afford to absorb the increased cost of technology.

In this paper, some of the factors conditioning the need for technology and the possibilities of it being taken up are considered against the background of the social and economic situation. However, there are so many interacting factors that it is often difficult to separate cause and effect.

## Climatic and geographic factors

Climate and geography impose severe limitations on what can be achieved, at reasonable cost, by the application of technology to the improvement of the fishing industry. All over the world fish, including shellfish, must be regarded as amongst the most highly perishable food products, the rate of spoilage being dependent on temperature. Under the high ambient temperature conditions encountered throughout the tropics, the rate of spoilage is high and, as a result, fish from these warm waters become unacceptable very rapidly unless measures are taken to preserve the quality.

There are enormous differences in the geographical situations of developing tropical countries but resources currently exploited in most village-level subsistence fisheries are those which are close at hand. Due to the time/temperature interaction and also the lack of suitable boats and gear, the local fishermen are prevented from fishing other potentially profitable stocks. If landings are made in or close to large cities, the problems of distribution and marketing are reduced. However, in an isolated village, that part of the catch which is surplus to the requirements of the local market must be transported to population centres, often over difficult terrain with poor roads. In many cases, due to the time involved and because ice is unavailable, it is necessary to extend the storage life by processing, eg by salting, drying or smoking. A similar situation applies in island communities where, in order to make financial gain, trade in fish not required by the local community must be established with other communities some distance away. Expensive transport of iced fish or processing and transport of processed products is then required.

The limitations to handling, processing and marketing fish in the tropics which are imposed by climatic and geographic factors are enormous. However, in most cases they are exacerbated by social and economic circumstances which are beyond the control of the fishermen, fish buyers and processors.

## Social and economic factors

The number of people involved in the fish production and distribution chain tends to be large in tropical fisheries. The fishermen, a number of buyers or middlemen, wholesalers, distributors and retailers all compete for the limited profits which are available. Of all these groups, the fisherman is least able to withstand inflationary costs or to pass on the increased cost of quality preservation. The activities of the others set the quantity, quality and price level at which the fisherman must produce. The fisherman is in an unenviable position; in general, he is not organized to market on a co-operative basis and the value of his product is declining with time. The middlemen and buyers justify their high profits by the risk that they take in employing their capital to purchase perishable products but often pay the fishermen only for that part of the catch which they successfully retail. There appears to be no prospect of breaking the circle of poor quality attracting low prices when improvements, which could be applied, would cost the producer money which he could not recover.

## Lack of infrastructure

In most situations, the small-scale fisherman lands fish which have often already started to spoil. They are generally unprepared, lack the time or do not have the capital to become processors and, as a result, they must sell their catch for the best available price with all the limitations outlined above. An organization, such as a co-operative, does not exist to protect their interests; their education is limited and they must spend their time at sea rather than conducting their business affairs ashore. There are instances of unscrupulous middlemen who artificially restrict the growth of the industry by keeping prices to the fishermen low. These are generally local businessmen of some importance who are making a good living and see a developing industry as introducing more competition.

Despite these social interactions, it is apparent that the lack of infrastructure is probably the greatest drawback to development in most village situations. Even given the resource, the catching capacity and the available market, no advantage can be taken without proper facilities. An ice plant, storage capacity for fish and ice, processing plant and an efficient transport and distribution network are all vitally necessary (but expensive) for landing places. When this infrastructure is provided, it is usually with government or international finance. This is necessary because the buying power of the consumers is seldom sufficient to encourage the private investor. Provision of the infrastructure makes improvement of cash incomes possible and this directly and indirectly spurs development.

## The trend to export

The low buying power of the local population encourages a tendency for the processing industry to concentrate its resources on export industries. In itself, exporting high priced species to lucrative markets can be justified to obtain foreign exchange. In any case, the amount of protein involved would not make a significant contribution to closing the protein gap. However, the trend to neglect the development of the fishery to satisfy the local, low-income market must be deplored as also must the processing of small volumes of high priced products for wealthy local consumers.

The lack of infrastructure and the low buying power of the local consumers will both improve with development. Apart from finance, the major prerequisite for development is that a body of trained and experienced people must be available to encourage, advise and guide the whole fishing industry. This problem cannot be solved rapidly solely by the injection of finance but will require the setting up of schools to train teachers, with selection and training of extension workers by these teachers.

Subsequently, the extension workers must be supported in the field as a group dedicated to improving local conditions.

## Avoidable losses

The amount of fish that is caught in the tropics and, for one reason or another, is not used as human food is impossible to quantify. It cannot be said that all of the portion not used for direct human nutrition is wasted since, in many cases, a high proportion is used in feeding domestic animals and in aquaculture. In addition, a number of species are not suitable for human consumption although sophisticated processing could make them available.

### *Fresh fish*

The actual wastage of fresh fish is high but figures are generally unreliable and vary greatly from place to place. Conservative estimates of more than five million tons have been made or more than ten per cent of that part of the world's fish catch used for direct human consumption. In addition, there are substantial losses of processed products. Increased production, both by fishermen and processors, is required to make up the losses, many of which could be avoided by the application of simple technology. It has been suggested that the cost of preventing waste could be higher than increasing production to make up for losses. The pressing need for protein requires that all attempts should be made to keep unnecessary losses to an absolute minimum, provided economic cost does not exceed the gain.

It is as difficult to determine where the losses take place as it is to measure them. There are physical losses of fresh fish or fish products through spoilage and also the economic losses resulting from inadequate facilities; these reduce the incentive to engage in fish production. The major loss of quality intrinsically attracts a lower price for immediate consumption but it must also be recognized that the potential storage life is also reduced and, therefore, prevents transport to distant markets. In most cases, the use of ice between catching and the market will ensure that the fish quality remains acceptable. However, if the buying power of the consumer is so low that he cannot afford the high quality product, with value added by icing, there can be no economic gain to producers and no incentive to ice fish. The observation, from many sources, that all fish of any quality are consumed means that, if there is profit in selling fish of indifferent quality, the capital expenditure and rise of producing high quality cannot be economically justified.

It is difficult to ascribe the responsibility for preventing wastage by improving quality to any sector of the industry. It is too simple a solution to suggest that the government should provide ice and expect that ice will then be used if one considers the economic background. There are many cases where this approach would work but, where the low-income group cannot afford the product, cheaper alternative forms of preservation are required although it is often remarked that, given the choice, consumers prefer fresh fish.

### *Processed products*

Salting, drying, smoking and a combination of all these methods are the traditional processes used to preserve surplus catches. However, their implementation requires organization, often lacking in tropical fisheries, where small volumes of fish are landed at scattered centres and the fishermen is reluctant or unable to act as a processor. A collection system to gather sufficient fish in one place for processing by traditional methods is a solution which has often been used. The extension of this system to large-scale mechanical production is questionable as energy costs rise rapidly.

In addition to the losses before processing, a figure of at least 30 per cent is accepted for the post-processing loss of salted and dried fish produced in tropical areas. Spoilage by bacteria, moulds and yeasts as well as high levels of consumption by insects, rodents and birds all contribute to these losses. In addition, poor packaging and crumbling of the product causes direct physical loss. Although it is impossible to reduce losses to zero, considerable improvement can be made. As an example, improved sanitation, protection in storage and insect control could contribute to reducing the enormous quantities of dried fish consumed by dermestid beetles, the most serious source of wastage in many countries. Once again, in order to have new ideas implemented, it is necessary to show that extra profit can be made in the marketplace by using new procedures. To accomplish this may take many years of extension work.

## Prospects for improvement

Improvement in the standard of living of the poor village fisherman depends not only on education and improvement of his social conditions but also on a general rise in living standards and buying power of the eventual customers. Thus, it is difficult to offer a plan for fisheries development which does not take these changing circumstances into account; concrete gains can be made by advances on a broad front rather than the piecemeal introduction of new technology which shifts the problems into other areas.

Technological improvements such as the introduction of ice, effective insulation and refrigeration prevent wastage by reducing spoilage. At the same time, they make the fisherman less vulnerable as he has more time to find a market. This may threaten traditional marketing arrangements and can interfere in the complex web of life in village communities. Government controlled co-operatives or joint marketing arrangements, competing with free enterprise, have been notably unsuccessful in resolving this dilemma; presumably because the innate conservatism and resistance to social change induces the same resistance even when direct economic benefits can be shown.

With improved education and living standards, increasingly strident demands are heard for the transfer of technology to developing countries. This should be done but not without careful identification of how much technology can be delivered and absorbed. A complex set of factors governs whether technological advances will be incorporated in traditionally orientated industries but the two major factors affecting the absorption of low and intermediate technology are that it must be simple and it must be cheap. All too often, international donors and governments try to achieve rapid development by grafting high technology industries into traditional communities. Although quick results may be achieved by subsidized project activities, they are not enduring and local development is undermined when traditional industries cannot compete.

It is, of course, recognized that many of the latent resources in tropical waters, such as the small pelagic fish, can only be exploited by the introduction of highly sophisticated industrial technology. However, an evaluation of all the circumstances must be made in every case. There are situations where maximum benefit to the whole population might be ahieved by industrializing the fishery, cutting out the labour-intensive traditional industries. Generally, however, it is more valuable to undertake a slow development process through the time-consuming method of working with local people. To be effective this requires training programmes for local extension workers, sympathetic to the needs of the people, and long-term support for their activities. It requires finance also for the improvement of the local infrastructure including landing places, ice plant, storage, transport and marketing facilities. Finally, it requires the adaptation and introduction of technology which can be shown to be effective economically and socially.

# Prospects for canning fish and shellfish in India

**K. K. Balachandran and M. R. Nair***
Central Institute of Fisheries Technology, India

## Summary

The export-orientated seafood canning industry of India is based exclusively on prawns. Prawn canning suffered a serious slow-down in recent years due partly to the decline in world demand for canned prawns and partly to the abnormal increase in the costs of raw prawns and cans in the country. This resulted in much of the plant capacity remaining idle. The probable solution for revival of the canning industry appears to be diversification of its produce by including commodities, other than prawns, for which there are existing international markets. Possible commodities are sardine, mackerel, clams, mussels, oysters etc, which are available in plenty in the country. The technology for canning most of these commodities has already been developed.

## Résumé

L'industrie de la mise en conserve des produits de la mer en Inde en vue de l'exportation concerne exclusivement les crevettes bouquet. La mise en concerne des crevette bouquet a subi une sérieuse régression au cours des récentes années, en partie à cause de la diminution de la demande mondiale en crevettes bouquet de conserve et en partie à cause de l'augmentation anormale du prix des crevettes crues et des boites de conserve dans les pays. Ceci a été pour une grande part la cause du ralentissement de l'activité des usines. La solution probable d'une reprise de l'industrie des conserves semble être la diversification de ses produits en y introduisant des éléments autres que les crevettes bouquet pour lesquels il existe un marché international. Les ressources possibles sont les sardines, maquereaux, palourdes, moules, huitres etc, que l'on trouve en quantité dans le pays. La technologie de la mise en conserve de la plupart de ces produits a déjà été mise au point.

## Resumen

La industria conservera de productos marítimos para la exportación de la India se basa exclusivamente en las gambas. En los últimos años esa industria se ha visto reducida, debido en parte a una disminución en la demanda mundial de gambas enlatadas y en parte al excesivo aumento en el país del coste de las dos materias primas: gambas y envases. Como resultado de esto, la mayoría de las instalaciones permanecieron inactivas. Una solución probable para el resurgir de la industria conservera podría ser la diversificación de sus productos, incluyendo otros además de las gambas, para las que ya hay actualmente mercados internacionales. Entre los productos posibles están las sardinas, caballa, almejas, mejillones, ostras, etc, que se encuentran con abundancia en el país. La tecnología para el enlatado de la mayoría de estos productos está ya muy desarrollada.

## Background situation

During the last fifteen years, India has emerged as one of the principal suppliers of processed fishery products to the world markets. However, the modern seafood processing industry in India has developed almost exclusively on one commodity, prawns, which contribute only about 10% to the total annual marine landings (Table 1). Frozen and canned prawns together contribute nearly 90% in value and 80% in quantity of the total marine product exports of the country (Table 2). In recent years, the canning industry in particular faced serious difficulties contributed to by, among other things, the dwindling world demand for canned prawns together with an unprecedented rise in the price of cans and the raw material; this has led to the virtual closure of the canning establishments in the country. Apart from prawns, other commodities which are canned in India on a very limited scale, almost exclusively for the domestic market, are sardine, mackerel, tuna etc.

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* Paper presented by T.S.G. IYER, Central Institute of Fisheries Technology, India.

TABLE 1. *Annual landings of certain marine fish and shellfish in relation to total marine landings (tonnes)*

| *Product* | *1970* | *1971* | *1972* | *1973** | *1974** |
|---|---|---|---|---|---|
| Prawns (Penaeid) | 89,812 | 72,109 | 77,492 | 136,680 | 114,934 |
| Oil sàrdine | 226,984 | 209,261 | 127,211 | 144,769 | 126,676 |
| Mackerel | 137,607 | 264,575 | 108,904 | 91,706 | 37,462 |
| Anchoviella | 24,400 | 19,516 | 18,681 | 25,344 | 41,507 |
| Other crustaceans | 10,662 | 9,612 | 11,598 | 12,573 | 16,663 |
| Total landings | 1,077,466 | 1,161,389 | 976,510 | 1,230,859 | 1,217,797 |

* Provisional
Source: Central Marine Fisheries Research Institute, Cochin.

TABLE 2. *Export of frozen and canned prawns in relation to the total export of marine products from India*

| | *1971* | | *1972* | | *1973* | | | |
|---|---|---|---|---|---|---|---|---|
| *Export* | *tonnes* | *rupees* | *tonnes* | *rupees* | *tonnes* | *rupees* | *tonnes* | *rupees* |
| Frozen prawns | 23,181 | 313,363 | 30,550 | 508,843 | 35,895 | 658,122 | 34,361 | 637,326 |
| Canned prawns | 1,864 | 29,757 | 1,058 | 21,026 | 2,191 | 52,369 | 1,516 | 47,842 |
| Total exports | 34,032 | 391,725 | 38,271 | 581,317 | 48,785 | 795,763 | 46,629 | 763,127 |

Source: Statistics of marine products exports, 1974. MPEDA, Cochin

There are a number of different types of canned seafoods popular in international markets. Sardine, in different packing media, clams, oysters, mussels, mackerel, tuna, crab etc are a few of those which are in great demand in the major importing countries such as the USA, UK, France, West Germany, Italy etc; India has a great wealth of all these raw materials. Canning these products, according to the requirements of the buyers and bringing about suitable modifications in the types of containers used, could solve the crisis in the Indian fish canning industry to a great extent.

## Sardine

Although oil sardine (*Sardinella longiceps*) is the most important fishery of India in terms of quantity, and is known to be the cheapest fish in the world, commercial canning of sardine for export has not been seriously attempted. With a plant capacity of 100,000 cans per day, the annual output of canned sardine has been meagre and highly fluctuating. Although there exists a very large international trade in canned sardine (Tables 3 and 4), the share contributed by India is nil.

TABLE 3. *Export of canned sardine from different countries (tonnes)*

| *Country* | *1970* | *1971* | *1972* | *1973* |
|---|---|---|---|---|
| Morocco | 36,300 | 46,000 | – | – |
| South Africa | 24,400 | 12,300 | 36,400 | 53,500 |
| Norway | 23,700 | 21,300 | 22,200 | 23,600 |
| Portugal | 23,300 | 28,000 | 29,100 | 32,600 |
| Spain | 26,800 | 29,300 | 3,500 | 33,500 |

Source: Yearbook of fishery statistics, 1972, 1973. FAO.

TABLE 4. *Import of canned sardines by principal importing countries (tonnes)*

| *Country* | *1970* | *1971* | *1972* | *1973* |
|---|---|---|---|---|
| USA | 30,100 | 25,600 | 34,300 | 24,400 |
| UK | 19,400 | 14,500 | 29,500 | 12,100 |
| France | 14,800 | 13,800 | 3,800 | 3,700 |
| Germany | 7,600 | 10,400 | 13,000 | 13,700 |
| Australia | 4,300 | 3,900 | 4,300 | 2,400 |
| Italy | 3,000 | 2,500 | 4,000 | 4,500 |

Source: Yearbook of fishery statistics, 1972, 1973. FAO.

The main problems associated with the development of a sardine canning industry in India are the seasonal nature of the fishery (concentrated in 3 to 4 months), abnormally high costs of containers and filling medium (resulting in very high production costs), non-availability of aluminium cans popular in overseas markets etc. The seasonal disadvantage can be dispelled since it has been found that sardine can be caught in off-shore waters during months that are out of season. For effective competition in the international markets, sardine packs of Indian origin have to be thoroughly modified in terms of container and contents. Indian packs are in tin cans of round or quarter dingly size. The packing medium generally used is refined groundnut oil; this has to be replaced by oleic oil or soya bean oil and the products diversified to the types such as 'skinless and boneless flesh' type produced by Portugal and Morocco, 'smoked type' of Norway or sauce packs of South Africa. Tin cans should be replaced by the easy open 'lift tab' or 'pull tab' type aluminium cans.

Attempts have been made to develop better packs of canned sardine and reduce the cost of production. Sen and Revankar (1971) observed that oil sardine canned in a 1:1 mixture of groundnut oil and sardine body oil can increase its acceptability. A solution of agar-agar as packing medium for sardine has been reported by Joseph and Jayachandran (1971). However, the most promising method of canning sardine appears to be the 'natural pack' method in which the fish is packed in its own juice. The process involves brining the cleaned fish in a solution containing common salt, potash alum and citric acid; these are then packed in cans and heat processed after exhausting in steam and seaming the can. The fish are attractive and the flavour excellent. The process is very simple and less expensive since the costly filling medium is dispensed with and, therefore, labour is also reduced. A process has also been developed for the canning of smoked sardine in oil and sauces (Unnikrishnan Nair, Balachandran and Madhavan, in press).

In order to boost the export of canned sardine, the Marine Products Export Development Authority has introduced a scheme of a cash subsidy, to the exporter, of 20% on FOB value. By developing the sardine canning industry in line with the requirements of the buyers, India can play a leading role in the international trade for this commodity. This alone can make up for most of the time the plant is not used to its full canning capacity.

## Mackerel

As with sardine, there also exists a large world trade in canned mackerel (Table 5). Despite having a substantial landing of mackerel (next to sardine in terms of quantity), India does not make any contribution to the international trade in canned mackerel. In the export market for canned mackerel the major share is contributed by Japan (Table 5); more than 90% of the Japanese packs are in brine and sauce while the oil pack represents only 5–6%. The small quantities of canned mackerel produced in India are packed exclusively in oil and are destined for the internal market only.

TABLE 5. *Export of canned mackerel by certain countries (tonnes)*

| *Country* | *1970* | *1971* | *1972* | *1973* |
|---|---|---|---|---|
| Japan | 161,200 | 177,300 | 184,500 | 178,000 |
| Morocco | 6,300 | 5,800 | – | – |
| Portugal | – | 10,300 | 11,000 | 9,900 |
| Norway | – | 1,100 | 800 | 900 |

Source: Yearbook of fishery statistics, 1972, 1973. FAO.

Several species of Atlantic and Pacific mackerels are used for canning; although comparatively small in size, the Indian species (*Rastrelliger kanagurta*) is quite suitable for canning. A great deal of work has been carried out in India on the canning of Indian mackerel with a view to producing an acceptable product with good organoleptic properties and storage life. A method has been reported for canning mackerel in oil as early as 1964. (Anon, 1964). After a careful study of the storage characteristics of mackerel in ice and subsequent canning, it has been reported that mackerel stored for more than three days are not suitable for canning (Madhavan *et al.*, 1970). Several attempts have been made to diversify this product and the process reported by Saralaya *et al.* (1975) for canning skinless mackerel fillets in oil merits special mention. Attempts have also been made for packing mackerel in brine. Exploiting the mackerel resource of the country for canning and export can fill a great gap in the much needed diversification of the canning industry in India.

## Clams and mussels

Although there are no reliable data on the resources of clams and mussels in India, it is well known that large quantities of clams (*Meretrix* spp. and *Velorita* spp.) are available in the brackish-water lakes and estuaries of Kerala. It has been stated that about 2,400 tonnes of clam meat are obtained from Vembanad Lake alone (Sebastian, 1970) of which only a negligible portion is consumed locally. Similarly, mussels (*Mytilus* spp.), occurring on the rocky structures along the West Coast, particularly off Kerala, and *Modiolus* spp., occurring along the East Coast, are very important raw materials. The characteristic taste of clams and mussels arises from their high glycogen content (Table 6) which is cherished by the consumer.

TABLE 6. *Proximate composition of clams and mussels*

| *% Composition* | *Clams* (Velorita *spp.*) | *Mussels* (Mytilus edulis) |
|---|---|---|
| Moisture | 82.5 | 85.0 |
| Protein | 8.8 | 8.4 |
| Fat | 1.4 | 1.2 |
| Glycogen | 3.1 | 3.5 |
| Ash | 2.2 | 1.4 |

Source: Balachandran and Nair, 1975.

There already exists a good market for these canned products. Export of canned clams by some producing countries is given in Table 7.

TABLE 7. *Export of canned clams (little neck) by some producer countries (tonnes)*

| *Country* | *1970* | *1971* | *1972* | *1973* |
|---|---|---|---|---|
| Canada | 1,800 | 1,800 | 2,100 | 2,600 |
| Singapore | 1,800 | 1,400 | 1,600 | 1,500 |
| Spain | 1,400 | 1,800 | 1,400 | 3,300 |
| Italy | 600 | 300 | 300 | 300 |

Source: Yearbook of fishery statistics, 1972, 1973. FAO

It has been observed that good quality canned products, comparable to those available in other countries, could be prepared using Indian clams and mussels. Realizing their potential, canning methods have already been developed as a means of diversifying the Indian canning industry. One difficulty was the grittiness of the meat due to the presence of a fairly high content of sand. This could be reduced by starving the live animal followed by treatment with chlorine (Balachandran and Nair, 1975). The resulting products have been found to be very good with respect to their taste, texture and flavour.

Other commodities, which could play an important role in revitalizing the canning industry of India, are edible oysters (*Crassostrea* spp.), crabs (*Scylla serrata* and *Portunus* spp.), anchoviella (*Engraulis commersonii*) etc. All these are available in substantial quantities and can be used profitably for canning especially since a market already exists for them. Research programmes, on how they could be canned to give the best acceptable products with good appearance, organoleptic qualities and storage life, are in different stages of progress at the Central Institute of Fisheries Technology, Cochin.

## References

**Anon.** (1964) *Fish Technol. Newsl.*, **5**(2),1.

**Balachandran, K. K. & Nair, T. S. U.** (1975) Diversification in canned fishery products – canning of clams and mussels in oil. Paper presented at symp. on *Fish processing in India* held at Cent. Food Technol. Res. Inst, Mysore, 13–15. February 1975.

**Joseph, K. C. & Jayachandran, P.** (1971) *Res. Ind.*, **16**(4), 267.

**Madhavan, P., Balachandran, K. K. & Choudhuri, D. R.** (1970) Suitability of ice stored mackerel and sardine for canning. *Fish Technol.*, 7(1), 67–72.

**Saralaya, K. V., Parashuram, P. & Rai, B. S.** (1975) Studies on canning of mackerel fillets in oil. *Fish Technol.*, **12**(2), 120–126.

**Sebastian, M. J.** (1970) *Seafood Export J.*, **2**(4), 25.

**Sen, D. P. & Revankar, G. D.** (1971) *Seafood Export J.*, **3**(12), 13.

# The control of insect infestation of fish during processing and storage in the tropics

**D. L. Proctor**
Tropical Products Institute, UK

## Summary

Insect infestation during drying and storage of fish in the tropics leads to substantial losses; some estimates are as high as 50 per cent. Insects, particularly blow-flies, may also contaminate fish with bacteria. The nature of infestation is discussed, blow-flies and dermestid beetles being recognized as the major insect pests of fish in the tropics. Blow-flies assume greatest importance during 'cool-wet' seasons, while infestations by dermestid beetles peak under 'warm-dry' conditions. Insect species and mites of lesser importance are also mentioned.

Chemical and non-chemical methods of controlling insect infestation are reviewed and reference is made to FAO/WHO tolerance limits on toxic residues in dried fish. The formula for effective control of insect infestation of fish is essentially a composite one, consisting of both chemical and non-chemical methods. The importance of hygiene at all stages in the handling of fish is stressed, while improved smoke drying and brining techniques minimize the risk of insect infestation and bacterial contamination. Preventative measures recommended include the wider use of fly-proof screens, polyethylene bags for transportation and storage, and the use of insecticides of low mammalian toxicity at dosage rates which leave residues within FAO/WHO tolerance limits. Fumigation is recommended for disinfesting containers and arresting established infestation of large stocks of dried fish.

## Résumé

L'infestation par les insectes au cours du séchage et du stockage du poisson sous les Tropiques provoque des pertes importantes dont l'estimatton atteint quelquefois 50 pour cent. Les insectes, en particulier les mouches à viande, peuvent également contaminer le poisson par les bactéries. La nature de l'infestation est discutée, les mouches à viande et les dytiques étant reconnus comme les insectes les plus virulents du poisson sous les Tropiques. Les mouches à viande jouent leur rôle le plus important pendant les saisons 'fraiches et humides' tandis que les infestations par les dytiques sont les plus importantes dans les périodes de 'chaleur sèche'. Des espèces d'insectes et des hydrachnes de moindre importance sont également citées.

Les méthodes non-chimiques et chimiques de lutte contre les infestations par les insectes sont passées en revue, référence étant faite aux limites de tolérance FAO/WHO des résidus toxiques dans les poissons séchés. La solution pour une réduction effective de l'infestation des poissons par les insectes est essentiellement une solution composite, consistant en méthodes à la fois non-chimiques et chimiques. On a insisté sur l'importance de l'hygiène à tous les stades de la manipulation du poisson alors que l'amélioration des techniques de préparation des poissons séchés et fumés et des poissons marinés dans la saumure réduisent les risques d'infestation par les insectes et de contamination bactérienne. Les mesures préventives recommandées comprennent une plus large utilisation de moustiquaires, de sacs en polyéthylène pour le transport et le stockage, et l'utilisation d'insectisides de faible toxicité pour les mammifères et à des doses qui laissent les résidus dans les limites de tolérance définies par FAO/WHO. La désinfection par fumigation est recommandée pour désinfecter les récipients et pour stopper les infestations existant dans les stocks importants de poisson séché.

## Resumen

Las plagas de insectos durante el secado y almacenamiento de pescado en los trópicos originan pérdidas importantes, que se han calculado a veces de hasta un 50 por ciento. Los insectos, sobre todo las moscardas, pueden contaminar también el pescado con bacterias. Se discute la naturaleza de las plagas, reconociéndose a las moscardas y a los escarabajos derméstidos como a los insectos más dañinos del pescado en los trópicos. La mayor actividad de las moscardas tiene lugar durante las estaciones 'frío-húmedas', mientras que la de los escarabajos derméstidos alcanza su auge en condiciones 'cálidas y secas'. También se hace referencia a otras especies de insectos y ácaros de menos importancia.

Se revisan los métodos de lucha contra las plagas de insectos por procedimientos químicos y no químicos, haciendo referencia a los límites de tolerancia FAO/WHO respecto a los residuos tóxicos en pescade seco. La fórmula para una lucha eficaz contra las plagas de insectos del pescado es por naturaleza compuesta, es decir comprende métodos químicos y no químicos. Se acentúa la importancia de la higiene en todo el proceso de manipulación del pescade, constatando que las técnicas avanzadas de secado por humo y de tratamiento con salmuera disminuyen el riesgo de infestación y la contaminación de bacterias. Se recomiendan medidas preventivas incluyendo un mayor uso de pantallas a prueba de moscas, bolsas de polietileno para transporte y almacenamiento y el uso de insecticidas de baja toxicidad para los mamíferos, con una dosificación que deje residuos aceptables para los límites de tolerancia FAO/WHO. Se recomienda la fumigación para desinfectar los contenedores y para detener las infestaciones ya iniciadas en grandes stocks de pescado seco.

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## Introduction

Under the hot and generally humid conditions of the tropics fish deteriorate rapidly after landing and methods of drying, salting or par-boiling have been developed as a means of prolonging shelf life and getting the fish to distant markets. Notwithstanding such efforts, processed fish are prone to infestation by certain insect species and mites which can cause considerable losses. Estimates of quantities of fish, too damaged by insect pests to be marketed, are sometimes put as high as 50%. Financial losses are correspondingly heavy (Aref *et al.*, 1964; Rollings and Hayward, 1962).

In addition to causing losses in quality and quantity, insect pests are potential carriers of pathogenic bacteria (Watanabe and Cabrita, 1971) and thus represent a health hazard. The author is not aware of any epidemic being traced to the distribution of infected fish but the risk clearly exists.

Successful methods of controlling insect pests of drying and dried fish have been developed but their adoption is far from widespread. The main difficulty is that the greater part of the fish industry in tropical countries is conducted by small traders under relatively primitive conditions, often in remote places. The extension of new techniques in such circumstances presents formidable problems, not the least of which are the lack of trained personnel to pass on information and the reluctance of many people to adopt new ideas.

## The nature of insect infestation

Insect pests are attracted to fish virtually from the time they are landed. Flies, the major carriers of diseases, are among the first arrivals. Of greatest concern are those species which are capable of breeding on fish; these include *Chrysomyia marginalis* Wied. (McLellan, 1963; Proctor, 1972) and *Wohlfartia* spp. (Green, 1967). These blow-flies will lay eggs on fish during the early stages of sun drying, becoming less attracted to them as the flesh dries and hardens (McLellan, 1963). The larvae tunnel into the flesh, causing putrefaction and extensive damage. They mature within one or two weeks and usually leave the fish to pupate (frequently in the ground beneath drying racks). *Piophila casei* L., the cheese skipper, has been observed infesting dried fish in Malawi, completing its life cycle within 19 to 23 days (Anon, 1963). Baker (personal communication) notes that the problem of blowfly infestation is greatest during the 'rainy' season in Malawi, presumably because sun drying takes longer at this time.

The most important insect pests of dried fish are beetles of the family Dermestidae. They will invade fish from the earliest stages of drying but, unlike flies, will continue to be attracted to, and breed in, the dried product. *Dermestes frischii* Kug. has been reported as the main pest of dried marine fish in South Arabia (Green, 1967) but records from elsewhere indicate that *Dermestes maculatus* Deg. is the most frequently encountered pest (Pillai, 1957; Sweeny, 1962; McLellan, 1964; Proctor, 1972). Mallamaire (1957) remarks that *D. frischii* normally infests marine fish while *D. maculatus* is most commonly associated with freshwater fish. *Dermestes ater* Deg. is found occasionally on dried fish but appears to be a relatively minor pest of the product (Green, 1967; Proctor 1972).

*Necrobia rufipes* Deg. (Coleoptera, Cleridae), the red-legged ham beetle, is frequently found breeding in dried fish but rarely in large numbers. It occurs usually in association with dermestid beetles, on which it is predatory. Osuji (1974) has conducted a study in Nigeria on the nature of infestations of dried fish by this species and *D. maculatus*. He noted how different larval instars appeared to prefer different parts of the fish and that beetle infestation is more severe during the 'warm-dry' season than during the 'cool-wet' season.

Other beetle species which are sometimes found on dried fish, but which appear to be no more than incidental, include *Tribolium castaneum* Herbst., *Trogoderma granarium* Everts and *Lasioderma serricorne* (F).

Mites (Arachnidae, Acarina) may occur on dried fish if they have not been dried properly or have taken up moisture during storage. Severe infestation has not been widely reported, possibly because the pest status of mites on stored fish has not been adequately assessed. Pillai (1957) recorded *Cheyletus munroi* Hughes, *Suidasia medamensis* Oud., *Lardoglyphus konei* (S. and A.) and *Glycycometus travoncoricus* gen. et sp. n. on stored fish in India. *S. medamensis, L. konei* and *Tyroglyphus* sp. were found on dried fish in Nigeria (Pest Infestation Control Laboratory communication to M. J. Rollings, 1962). Of these mite species only *L. konei* has been reported as actually feeding and breeding on the fish. The other species are predatory on *L. konei* or feed on the dead bodies of insect pests.

## Non-chemical methods of infestation control

In many fisheries and fish markets in tropical countries, the high infestation risk is associated with low hygiene standards. Even the most potent control measures can be rendered ineffective in situations where sanitary conditions are poor. Therefore, the very first step that must be taken is to keep places where fish are handled as clean as possible (Watanabe and Cabrita, 1971; Aref *et al.*, 1964).

At the end of each day's operation, the whole area in which fish have been handled, including all equipment, should be thoroughly cleaned. All fish residues should be gathered together for disposal and not left to serve as breeding grounds for insect pests. If arrangements have not been made to remove the fish residues for conversion into fertiliser, they should be buried or destroyed in an incinerator. At the fish landing, it may be expedient to return waste to the open water, where it can be consumed by fish and other organisms. These basic measures should be possible even in the most undeveloped fishing situations.

Buildings used as fish stores and markets are often fitted with fly-proof screens and self-closing doors. However, these protective measures are rarely employed at fisheries where screens would appear to serve a particularly useful purpose. Different kinds of screening materials are described by Blatchford (1962).

Sticky fly-traps or swats may be employed to deal with the occasional intruders into screened places. Alternatively, where there is a mains electricity supply, insect electrocutors could be installed.

All stages of insects, from egg to adult, are killed by temperatures in excess of 50°C (Blatchford, 1962). Szabo (1968) exploited this phenomenon in Mali by placing frames, with transparent polyethylene sides and tops, over bundles of infested dried fish weighing up to 65 kg. The temperature inside these cages rose to 80°C within 30 minutes, forcing insects out through the bottom or killing them. Toye (1970) has suggested heating dried fish in simple charcoal fired ovens for 30 minutes at four day intervals during the storage period to control infestation. Cutting *et al.* (1956) warn that artificially heating fish above 65 to 70°C may cause scorching and spoil the colour or flavour of dried fish. The range of temperatures available for killing pests without spoiling fish is, therefore, very narrow and the warm smoking technique (45 to 60°C for 4 to 7 hours for larger fish) recommended by Watanabe and Cabrita (1971) is probably the best method to adopt.

Keshvani (1964) observed that well dried fish could be stored for up to one year in sealed polyethylene bags without serious loss of quality. However, Cole (1963) found that the sharp projections of dried marine fish punctured polyethylene bags. Nevertheless, both Watanabe (1971) and Toots (1972) recommend sealing dried fish in these bags, the latter emphasizing the need to cool the fish after thorough drying and to store the product in a cool shady place to avoid sweating.

## Chemical methods of infestation control

Treating fish with salt (sodium chloride) during the drying process is probably the oldest method of improving their keeping quality. The primary effect of salt is bactericidal but there is no doubt that it also retards the development of insect infestations. Flies are not attracted to salted fish at all, while the degree of attraction to adult dermestid beetles is inversely related to the amount of initial salting (Green, 1967). Kenching, ie rubbing salt into the fish before drying, is not as effective in this respect as brining (leaving fish to soak in saturated salt solution: the saltiness of the product being determined by the size of the fish and the length of time it is left in the brine). Eggs laid by dermestid beetles on salted fish may hatch but the emerging larvae are slow to develop and suffer high mortality (Osuji, 1975). Well dried and brined marine fish will not be infested for at least six weeks (Green, 1967).

Heavily salted fish is not a universally acceptable product and, to meet the requirements of some markets (Watanabe and Dzekedzeke, 1971), the salt content has to be limited to 10% or less. At this level, some insect infestation is inevitable (Proctor, 1972). Pillai (1957) found that par-boiling prawns in 2.5 to 5.0% salt solution before sun drying prevented infestation by the mite *L. konei* for 45 to 56 days.

Drying fish over smoky fires is frequently practised, the product acquiring a flavour which is preferred to that of sun dried fish. Aref *et al.* (1965) reported from Mali that smoke drying over hardwood sawdust fires appeared to impart some protection against insect infestation. However, Conway (personal communication) observed infestation of fish after drying over smoky hardwood fires for different lengths of time in The Gambia; he concluded that it was the dryness of the product, rather than any property of the smoke, which affected insect attack.

Amorphous silica-based dusts, which are virtually non-toxic to mammals (Kane, 1967), have been tried on dried fish (Green, 1967; Proctor 1972) but were found to be ineffective because they absorbed oil from the fish. Aref *et al.* (1965) tried sulphur dipping and fuming with equally poor results.

Malathion has been shown to give good control and subsequent protection but minimum effective doses left undesirably high toxic residues on treated fish (Green, 1967; Proctor, 1972). The potential usefulness of fenitrothion and iodofenphos for controlling insect pests of dried fish has been demonstrated in The Gambia by Conway (personal communication). Similarly, dichlorvos impregnated paper strips disinfested and prevented reinfestation of dried fish packed in unsealed polyethylene bags in Botswana (Tyler, personal communication). However, further work is needed before any of these insecticides can be considered for general use.

So far, the only insecticides, which have been successfully introduced for the treatment of dried fish, have been based on pyrethrins synergized with piperonyl butoxide. A dust formulation containing 0.15% w/w pyrethrins and 2.4% w/w piperonyl butoxide, primarily intended for the protection of stored grain, has given three to four months protection from dermestid infestation when applied directly to dried fish in Zambia (Blatchford, 1962). McLellan (1963), working in Uganda, found that dipping *Tilapia* spp. in water emulsion containing 0.125% w/v pyrethrins and 1.25% w/v piperonyl butoxide prior to sun drying prevented infestation by blow-flies but did not confer lasting protection against dermestid beetles. Such protection was subsequently achieved (McLellan, 1964) by dipping fish in water emulsion containing 0.018% w/v pyrethrins and 0.036% w/v piperonyl butoxide after drying. Providing the fish were properly dried beforehand and adequately drained after treatment, they did not become too moist for storage and were quite acceptable to consumers. This treatment was shown to be the best of several tried by Proctor (1972), who also demonstrated that its employment by fish traders resulted in net profit increases of up to 90% and, possibly due to its repellent effect against insects, a product which was bacteriologically improved. Baker (personal communication), using the same formulation in Malawi to protect *Lethrinops* spp. from blow-fly infestation during sun drying, found up to 2.4 parts per million (ppm) pyrethrins and 4.6 ppm piperonyl butoxide in the four-day-old product. The blow-flies were controlled but subsequent dermestid infestation was not prevented. Other formulations are being tried to find out whether residues can be kept within the tolerance limits of 3.0 ppm pyrethrins and 20 ppm piperonyl butoxide (Anon., 1973), while conferring the desired post-drying protection.

This problem of having to keep residues within tolerance limits is the main disadvantage of treating fish directly with insecticides. It is an obvious necessity which imposes marginal effectiveness of proven treatments and stresses the need for the development of insecticides of even lower mammalian toxicity than those already tried.

Alternatively, insecticides may be applied to containers, used for the storage and transportation of dried fish, or to places in which fish are handled. Lindane (gamma BHC) has been used to impregnate sacks (Galichet, 1960) or spray boxes (Nonaku, 1952) for the successful protection of fish transported and stored in them. However, Proctor (1972) found that dermestid beetles penetrated sacks treated with a dust formulation of synergised pyrethrins and infested the contents. Blatchford (1962) pointed out that insecticidal treatment of containers could taint or contaminate the contents and suggested that such problems might be avoided by lining the treated containers with polyethylene or similar material.

Gjessing (communicating with the Tropical Stored Products Centre in 1961) reported that the application of 20% lindane to the ground beneath fish drying racks controlled blow-fly populations. Watanabe and Cabrita (1971) recommended using trichlorphon for the same purpose.

The treatment of buildings used regularly as stores or markets for fish with insecticides could be a useful adjunct in any pest control scheme. Regular spraying of internal surfaces or fogging with contact insecticides (outside normal working hours, when fish stocks are depleted or packed away) should help to prevent the development of indigenous pest populations, especially in places where infestation pressure is considerable.

Established infestation of relatively large stocks of dried fish can be dealt with most satisfactorily by fumigation. The simplest procedure is to conduct the fumigation under a gas-proof sheet. Amaro and Soares de Gouvela (1957) reported successful fumigation of dried fish under gas-proof sheeting in Angola, using 24 g methyl bromide per cubic metre for 24 hours. Similar treatment may be applied to entire buildings if they can be suitably sealed or covered with gas-proof sheeting. Alternatively, specially constructed gas-tight chambers may be used: either at normal atmospheric pressure or at reduced pressures (vacuum fumigation). In francophone African countries dried fish are fumigated with 80 to 100 g methyl bromide or 150 g ethylene oxide per cubic metre for 2 hours under vacuum (Mallamaire, 1957). At normal atmospheric pressure and using the same concentration of methyl bromide, it takes 6 hours to disinfect dried fish (Galichet, 1960).

Aref *et al.* (1964), investigating the possibility of controlling dermestid beetles in dried fish by means of ionizing radiation, found 53,000 to 105,000 rad to be lethal to adults. Also, 23,000 rad did not kill but probably induced sterilization.

**Summary of recommended control measures**

1. Wherever fish are processed, stored or marketed:
   (a) Keep the premises, and surrounding area, clean by daily removal (preferably destruction) of fish residues and liberal use of water to wash working areas and equipment.
   (b) Treat drains and soak-aways in the vicinity regularly with disinfectant to destroy bacteria and discourage flies.
   (c) Use fly-proof screens and self-closing doors to prevent flies gaining access to fish.
   (d) Hang up sticky fly-traps or, if practical, install insect electrocutors.
   (e) Prevent the development of indigenous pest populations by regularly spraying internal surfaces of buildings or space fogging with contact insecticide (outside normal working hours and ensuring that stocks of fish are covered to avoid contamination).
   (f) If possible, construct the floor of smooth-capped concrete (also under drying racks) to facilitate cleaning and eliminate an important breeding ground for flies.

2. Ensure that vehicles used for transporting fish are clean and free from infested residues before use and clean them after use. Regular fish transporters could be fitted with (detachable) fly-proof screens and self-closing doors; they should be sprayed internally with contact insecticide at regular intervals.

3. Containers, (boxes, sacks etc) for the transportation and storage of fish, should be cleaned and disinfested before use. Sizeable concerns could equip themselves with facilities for cleaning and fumigating containers but small-scale traders are unlikely to be able to do this. Municipal or Central Government Authorities may be

able to help here by installing the required equipment in or near important fish markets and charging a nominal fee for container disinfection. Polyethylene (or other plastic) bags should be used in situations where their practicality has been demonstrated, providing the precautions associated with their use can be observed.

4. Improved smoke drying and brining techniques minimize the risks of insect infestation and bacterial contamination; they should be employed wherever the product has a ready market. In the absence of such a market, serious consideration should be given to mounting campaigns to gain their acceptance by consumers.

5. The direct treatment of drying or dried fish with contact insecticides of low mammalian toxicity at dosage rates, which leave residues within FAO/WHO tolerance limits, should be encouraged if:
   (a) No other means of coping with pest infestation is as practical or economical.
   (b) The techniques employed are simple and virtually fool-proof.

6. Municipal or Central Government Authorities should ensure that fumigation facilities (private or otherwise) are available so that established infestations of dried fish stocks may be dealt with.

## References

**Amaro, J. P. & Soares de Gouveia, A. J.** (1957) Estudos, Ensaios e Documentos XL. Aspectos de defensa fitossanitaria dos produtos armazenados en Angola. Lisboa: Ministr. Ultramar, *J. Invest. Ultramar,* pp.112.

**Anon.** (1963) *Annual Report of the Department of Agriculture, Nyasaland, 1961/62.*

**Anon.** (1973) *Pesticides residues in food.* Report of the 1972 Joint FAO/WHO Meeting. Rome: FAO.

**Aref, M., Timbely, A. & Daget, J.** (1964) Fish and fish processing in the Republic of Mali. 3. On the destruction of dried fish by the dermestid insects. *Alex J. Agric. Res.,* **12**(2), 95–108.

**Blatchford, S. M.** (1962) Insect infestation problems with dried fish. *Trop. Stored Prod. Inf.,* No 4, 112–128.

**Cole, R. C.** (1963) Fish curing industry in Aden. *Trop. Prod. Inst. Rep.* 22/63.

**Cutting, C. L., Reay, G. A. & Shewan, J. M.** (1956) Dehydration of fish. *Dep. Sci. Ind. Res., Food Investigation, Special Report* 62, p.145.

**Galichet, P. F.** (1960) La protection du poisson sec contre le dermeste *Dermestes maculatus* Deg. dans le bassin Tehadien. *C. R. Acad. Agric. Fr.,* **46**(7), 404–410.

**Green, A. A.** (1967) The protection of dried sea-fish in South Arabia from infestation by *Dermestes frischii* Kug. (Coleoptera, Dermestidae). *J. Stored Prod. Res.,* **2**, 331–350.

**Kane, J.** (1967) Silica-based dusts for the control of insects infesting dried sea-fish. *J. Stored Prod. Res.,* **2**, 251–255.

**Keshvani, K. J.** (1964) Pilot scale production of dried fish at Aba, Eastern Nigeria. *Res. Rep., Fed. Inst. Industr. Res., Nigeria,* 27.

**Mallamaire, A.** (1957) Les insectes nuisibles au poisson seche en Afrique. Moyens de les combattre. *Bull. Prot. Veg.,* **57**, 89–99.

**McLellan, R. H.** (1963) The use of a pyrethrum dip as protection for drying fish in Uganda. *Pyrethrum Post,* **7**(1), 8–10.

**McLellan, R. H.** (1964) A pyrethrum-dipping treatment to protect dried fish from beetle infestation. *Pyrethrum Post,* 7(3), 30–40.

**Nonaka, J.** (1952) The control of insects which injure the dehydrated marine foods by gamma BHC. *Bull. Jap. Soc. Sci. Fish.,* **17**(12), 401–404.

**Osuji, F. N. C.** (1974) Beetle infestation in dried fish purchased from a Nigerian market, with special reference to *Dermestes maculatus* Degeer. *Niger. J. Entomol.,* **1**(1), 69–79.

**Osuji, F. N. C.** (1975) The effects of salt treatment of fish on the developmental biology of *Dermestes maculatus* (Coleoptera, Dermestidae) and *Necrobia rufipes* (Coleoptera, Cleridae). *Entomol. Exp. Appl.,* **18**(4), 472–479.

**Pillai, P.** (1957) Pests of stored fish and prawns. *Bull. Res. Inst. Univ. Kerala* (c) **5**(3), 79pp.

**Proctor, D. L.** (1972) The protection of smoke-dried freshwater fish from insect damage during storage in Zambia. *J. Stored Prod. Res.,* **8**, 139–149.

**Rollings, M. J. & Hayward, L. A. W.** (1962) Aspects of the dried fish trade in Nigeria with particular reference to Lake Chad. *Rep. West Afr. Stored Prod. Res. Unit,* 1961 115–120.

**Sweeney, R. C. H.** (1962) *Insect pests of stored products in Nyasaland.* Department of Agriculture, Zomba.

**Szabo, A.** (1968) Harnessing the sun to save infested fish. FAO News Feature.

**Toots, H.** (1972) Fish preservation. *Rhod. Agric. J.,* **69**(1), 1–5.

**Toye, S. A.** (1970) Studies on the humidity and temperature reactions of *Dermestes maculatus* Deg. (Coleoptera, Dermestidae) with reference to infestation in dried fish in Nigeria. *Bull. Entomol. Res.,* **60**, 23–31.

**Watanabe, K.** (1971) Improved method of preparing dried sardine from Lake Tanganyika. *Rep. Minist. Lands and Natural Resources, Dep. Wildlife, Fisheries and National Parks, UN/FAO Central Fisheries Research Institute, Zambia.*

**Watanabe, K. & Cabrita, F. J.** (1971) Directions for the preparation of salted and dry-smoked fish. *Fish. Res. Bull. Zambia,* **5**, 225–233.

**Watanabe, K. & Dzekedzeke, O.** (1971) Taste preferences of Zambians for various types of dried and smoked fish. *Fish. Res. Bull. Zambia,* **5**, 199–206.

# Some protective measures against insect infestation of dried fish in Africa

**E. Kordyl**

FAO, Lake Tanganyika Fisheries Research and Development Project, Tanzania

### Summary

A brief review of some work on the use of insecticides to control insect infestation in dried fish is given. Comments are made on possible health hazards to the consumer by the indiscriminate use of insecticides and the apparent lack of co-ordination between health authorities and scientists working in this field.

### Résumé

Une brève revue de quelques travaux sur l'utilisation des insecticides pour réduire l'infestation du poisson par les insectes constitue le sujet de cette publication. Des remarques sont faites au sujet d'éventuels dommages pour la santé des consommateurs du fait de l'utilisation irraisonnée d'insecticides et du manque apparent de coordination entre les autorités sanitaires et les travaux scientifiques dans ce domaine.

### Resumen

Se hace una breve revisión de algunos de los trabajos sobre el uso de insecticidas para controlar las plagas de insectos en el pescado seco. Se hacen comentarios sobre los posibles riesgos para la salud del consumidor por el uso indiscriminado de insecticidas y la falta aparente de coordinación entre las autoridades sanitarias y los investigadores en este campo.

## Introduction

In Africa, almost every kind of foodstuff (particularly those containing protein), if not properly protected, is easily infested by a large variety of insects which cause damage to the product. The most effective methods of preservation which prevent infestation entirely are refrigeration, freezing and canning but, at present, these methods are still in the initial stage of application, mainly in larger towns.

Sun drying, which is widespread in Africa, is the simplest and most economical method of fish preservation. However, this method also has important disadvantages since it offers a favourable environment for insect infestation and for the development of rancidity.

Insect infestation in dried fish is a serious problem in much of Africa; no simple, safe and inexpensive method of protection has, as yet, been developed. In order to solve this problem some research has been carried out but little information is available on practical insect control. From the author's personal observations and from information obtained at a recent seminar held in Zambia (which was attended by representatives of 14 African countries), there is little evidence of the application of protective measures against insects on a large commercial scale (FAO, 1975). The author considers those aspects which seem to be important to those who are trying to solve this complicated problem.

## Methods of insect control in dried fish

Fish are exposed to insect activity soon after landing and during processing, transportation and storage. The intensity of infestation depends on many factors; among the most important are the presence of insects, the drying conditions and the period of storage.

There are two stages of insect infestation. The first is relatively short term; different species of flies infect the fish when they are still wet. The second is long term; different species of *Dermestes, Chrysomya* and *Necrobia* infect the dry (or drying) fish. Methods of protection against insect infestation described in the literature deal mainly with chemical methods (using insecticides); few authors have considered physical methods of control.

McLellan (1965) recommended a short immersion of wet fish in pyrethrum solution (0.125% w/v) for the short term control of flies. For the long-term control of other insects he recommended immersion of the dried fish in a more dilute solution (0.018% w/v). After the second immersion, the dried fish were packed in jute bags without exposure to the sun, to avoid photolytic deactivation of the insecticide. This method was effective for 8 to 12 weeks.

Szabo (1970) recommended a combined physical and chemical treatment for the long-term control of insects in dried fish. Initially the fish were heated to kill the insects in all stages of development. The fish were then packed in palm mats which had been sprayed with insecticide solution. This method has been applied mainly to large fish.

Conway (unpublished work) tried three different methods of treatment (dusting, spraying and dipping) with several insecticides on dried fish. Although some of these methods were successful, the author was reluctant to recommend any of the methods without further trials being carried out.

Horn (1974) has introduced improved methods for commercial drying of small sardines from Lake Tanganyika; these include some physical measures to control insect attack. After brining, sardines are pre-dried on elevated drying racks in the sun for several hours. They are then transferred to the smoking kiln for the completion of drying at a temperature of approximately 100°C; this step also serves to eradicate insects. Afterwards the dried fish are sealed in plastic bags and packed in cartons. This method eliminates initial insect infestation and can be effective for long periods if the fish are stored under controlled conditions. Under poor storage conditions the insects drill holes in the plastic bags and infest the fish.

The author, following experiments carried out by McLellan, has investigated the Faru-tox emulsion produced by Kenya Apiaries Ltd to control flies and other insects in dried sardines from Lake Tanganyika. Experiments on long-term control of insects, particularly *Dermestes,* showed the Faru-tox to be effective for 4 to 6 weeks. Subsequently a few insects appeared and started breeding after 2 weeks; after 4 months all samples were heavily infested.

Flies appear in large numbers several times a year, mainly during the rainy season. Brining is sufficient to keep flies away and prevent larval development. Large sardines (more than 10 cm in length) have to be nobbed before brining and drying, otherwise they rot and are often heavily infested before the drying process is completed.

## Comments on the control of insects in dried fish products

Any programme of fishery development in Africa, particularly fish processing and marketing, should take into consideration all possible aspects of insect control. In circumstances where large numbers of insects of different kinds are widespread there is almost no chance of avoiding infestation without the application of protective measures. Recommended means of control, which may be applied on a commercial scale and are without health hazard to the consumer, are still awaited. This is extremely important on the African Continent, where different insecticides, detergents etc are handled and used carelessly, causing heavy pollution of rivers and lakes. People responsible for the production, transportation, distribution and utilization of insecticides such as DDT have little idea of the hazards of such procedures and more control is needed.

The position of health authorities on insecticides is still not clear; this applies particularly to the World Health Organization. There also appears to be a lack of co-ordination between the scientists involved in experimental work and the authorities responsible for health hazard. Many times in the past, work has been carried out on different chemical compounds for use in the treatment of food products and these compounds have subsequently been banned by health authorities. Therefore, suggestions concerning insect control using insecticides should be discussed with the authorities concerned, taking into account local conditions including public health.

As regards the procedure for using insecticides, short dipping in a very dilute solution is appropriate. After dipping, the excess liquid must be drained off and the fish must be re-dried in the shade to avoid deactivation of the insecticide by sunlight. For commercial-scale operations this type of treatment seems to be very impractical since special facilities would be needed for re-drying. On the other hand, in a mechanical drying kiln, the increased temperature has an effect similar to that of the insecticide if the fish are subsequently sealed in plastic bags.

Physical methods of insect control are completely safe and their application depends mainly on technical and economic factors. From a practical point of view, it would be desirable to concentrate more on the improvement on existing physical methods and also on the development of new ones.

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## References

**FAO/SIDA.** Seminar on the planning and implementation of fish utilization programmes in Africa. Lusaka, Zambia, May 1975.

**Horn, H. J.** (1974) Processing of Lake Tanganyika sardines in Burundi. In: *Fishery products* (ed. R. Kreuzer), pp. 218–221. Surrey, England: Fishing News (Books).

**McLellan, R. H.** (1965) Insect damage to dried fish – a remedy. *Norw. Fish. Marit. News* No. 11.

**Szabo, A.** (1970) Améliorations possibles d'utilisation des produits de la pêche. UNDP (TA) No. 2900. Rome: FAO.

# Traditional processing in the Philippines

**F. R. Gonzales**

Bureau of Fisheries and Aquatic Resources, Philippines

## Summary

Fish processing in the Philippines is confined mainly to traditional methods of drying, salting, fermenting and smoking. These methods are briefly described as are non-traditional methods such as freezing, canning and mincing. The fishing industry, despite having an annual fish production of more than 1 million tonnes, is unable to meet the demand for fishery products. Brief mention is made of the steps that the Bureau of Fisheries and Aquatic Resources is taking to eliminate wastage and improve processing.

## Résumé

Les méthodes de préparation du poisson aux Philippines se limitent essentiellement aux méthodes traditionnelles de séchage, de saumure, de fermentation et de fumure. Ces méthodes sont brièvement décrites ainsi que des méthodes non traditionnelles telles que la congélation, la mise en conserve et lá mise en hachis. L'industrie de la pêche malgré une production annuelle de poisson de plus d'un million de tonnes est incapable de répondre à la demande en produits de la pêche. Brève mention est faite des mesures que le Bureau de la Pêche et des Ressources Aquatiques prend actuellement pour supprimer le gaspillage et améliorer les méthodes de préparation.

## Resumen

La elaboración de pescado en Filipinas se limita a los métodos tradicionales de secado, salazón, fermentación y ahumado. Se describen brevemente estos métodos así como los no tradicionales, como congelaciòn, enlatado y picado. La industria pesquera, a pesar de tener una producción anual de más de 1 millión de toneladas, es incapaz de cubrir la demanda de productos pesqueros. Se hace una breve mención de las medidas tomadas por la Oficina de Pesca y Recursos Acuáticos para eliminar las pérdidas y mejorar la elaboración.

## Introduction

The Philippine fisheries industry operates over an area covering 1,666,000 km$^2$ of the sea, approximately 9,000 km$^2$ of fresh water and 3,000 km$^3$ of brackish-water swamplands. These bodies of water contain some 2,000 species of fish and a few species of molluscs, crustaceans, echinoderms (sea cucumber), jellyfish, sponges, corals, turtles, amphibians, seaweeds and other acquatic fauna and flora of economic value. Of the country's marine resources, the coastal waters and shallow seas are intensively exploited leaving the offshore waters, the deep sea and the adjacent high seas practically untapped. Of the brackish-water swamplands available for fishpond purposes, only approximately 30% has so far been developed, the rest is idle or unproductive.

The preservation and processing of fish in the Philippines requires considerable care since the tropical temperatures and high humidity promote fish spoilage. Other factors, such as distance from fishing grounds, lack of refrigeration facilities etc, make it difficult to keep fish fresh. Temporary fish preservation is achieved by the use of crushed ice.

## Traditional products

Fish processing in the Philippines is confined mainly to traditional methods such as drying, salting, fermenting and smoking.

### *Dried*

The most common method of processing is drying; approximately 25 to 30% of the total catch is processed in this way. Sun drying is the simplest and most popular method. Finished products are packed in standard cases of 25 kg of small fish, while the larger fish are wrapped in matting materials in various sized bundles. Dried fish are transported to Manila by truck, train or boat. The species commonly used for drying are anchovy, mackerel, squid, sardine and slipmouth. Anchovies and sardines constitute the bulk of dried fish in the inter-island trade.

### *Salted*

The practice of salting fish has improved little over the years; fishermen still cling to the old, crude methods. Kench curing, as used in the Philippines, denotes sardine or other small fish which are salted in brine, drained overnight and then packed in loose salt. The finished products are then packed in wooden boxes or wicker baskets lined with mats or plastic film.

### *Fermented products*

Fermentation using salt is also a common way of preserving fish. The products obtained are fish paste (bagoong) and fish sauce (patis). Small fish, which do not achieve high prices in the market, are used. Some of the species used are *Stolephorous* sp., *Sardinella* sp., *Anadontostoma* sp., *Decapterus macrosoma* and other mixed small fish.

### *Smoked*

Fish smoking is mainly carried out in villages, towns and cities or where daily transport of smoked fish to the central markets is possible. Smoked fish in the Philippines, which is Chinese in origin, differs from the smoked fish found in temperate countries since the fish are cooked in brine prior to smoking. Hot smoking is commonly employed. The finished products are sold directly in the trays in which they are smoked; the used trays are shipped back to the processors. During the peak season the fish are cooked in bulk, stored in a cold store and smoked later when supplies are scarce. Species used for smoking are sardine, milkfish and round scad.

## Non-traditional and industrial products

### *Frozen*

Fresh fish are generally marketed whole or in the round but large fish are occasionally sold as steaks or chunks. At present, most of the supermarkets in Greater Manila sell frozen fish (whole or gutted), some also sell fish fillets packed in plastic bags. The exported frozen products are shrimps, tuna, scallops, cuttlefish and milkfish. The exporters have acquired the necessary experience in preparing and shipping a wide range of products.

### *Canned*

Canning of fish in the Philippines started before the war; however, the canneries failed due to the high cost of raw materials and supplies which made it impossible for them to compete with the imported products that have been flooding the market. There are only two known canning establishments today, the Visayan Packing Corporation and the Purefoods Corporation, which only use tuna. Production has been on a small scale, each plant using about one ton of raw material daily, with an output of about 40 cases (48 x 7 oz cans) of light tuna meat solid pack. All the products are sold in the local markets.

### *Minced*

The manufacture of fish sausages and cakes was introduced into the Philippines as early as 1957 by a Filipino Fishery Technologist who had undergone training in Japan. The products have been found to be acceptable but they are not yet produced commercially. These products utilize shark, tuna, croaker and lizard fish. The success of the fish sausage industry in the Philippines will depend on the availability and cost of the raw materials and the economical cost of production.

## Available resources

Annual fish production in the Philippines is more than one million tonnes. There are about 100 species of commercial value and those commonly used for processing are tuna, herring, round scad, mackerel, anchovy, slipmouth, squid and shrimp. The commercially important species and the quantities caught are given in Table 1. The chemical composition of these fish is shown in Table 2.

TABLE 1. *Annual catch of species used for processing*

| *Common name* | *Scientific name* | *Total catch (kg)* |
|---|---|---|
| Anchovy | *Stolephorous* sp. | 11,055,890 |
| Big-eyed scad | *Selar chromenopthalmus* | 13,517,400 |
| Caesio | *Caesio* sp. | 19,066,230 |
| Cavalla | *Caranx* sp. | 6,326,960 |
| Chub mackerel | *Scomber japonicus* | 25,875,030 |
| Crevalle | *Caranx* sp. | 3,012,040 |
| Croaker | *Otolithus argenteus* | 8,736,200 |
| Grouper | *Epinephelus* sp. | 2,364,140 |
| Hairtail | *Trichiurus* sp. | 4,869,300 |
| Lizardfish | *Saurida* sp. | 7,562,820 |
| Round scad | *Decapterus* sp. | 169,967,890 |
| Sardine | *Sardinella* sp. | 39,740,220 |
| Slipmouth | *Leiognathus* sp. | 40,571,080 |
| Snapper | *Lutjanus* sp. | 3,146,940 |
| Squid | *Loligo* sp. | 7,174,460 |
| Shrimp | *Penaeus* sp. | 10,369,380 |
| Surgeon-fish | *Acanthurus* sp. | 3,465,920 |
| Yellowfin tuna | *Thunnus* sp. | 6,864,820 |

Source: *Fisheries statistics of the Philippines, 1973*, Bureau of Fisheries and Aquatic Resources, Economics and Information Division, Manila, Philippines.

TABLE 2. *Proximate analysis of species used for processing*

| *Species* | *% Moisture* | *% Protein* | *% Fat* |
|---|---|---|---|
| Anchovy | 73.71 | 19.49 | 1.51 |
| Big-eyed scad | 78.37 | 19.04 | 1.75 |
| Caesio | 78.11 | 18.93 | 0.27 |
| Cavalla | 77.49 | 22.04 | 0.43 |
| Chub mackerel | 79.01 | 17.15 | 1.62 |
| Crevalle | 76.57 | 19.16 | 1.67 |
| Grouper | 78.84 | 20.79 | 0.31 |
| Lizardfish | 77.29 | 19.54 | 0.79 |
| Round scad | 74.19 | 21.90 | 0.95 |
| Sardine | 75.87 | 19.87 | 1.36 |
| Snapper | 78.80 | 17.66 | 0.81 |
| Slipmouth | 79.50 | 17.32 | 1.82 |
| Squid | 25.00 | 71.00 | 1.80 |
| Surgeon-fish | 79.77 | 19.19 | 0.43 |

## Problems restricting development

The inability of the fishing industry to meet the existing requirements for fishery products has been attributed to a number of factors. These include the following:

1. Improper fish handling practices among fishermen.
2. A need to improve the processing of traditional products and the development of new ones for export and for import substitution.
3. Poor marketing and distribution of fish and aquatic products. This may be attributed to poor facilities for transport, aggravated by the geographical and climatic conditions.
4. Lack of fishery infrastructure such as ports, harbours, ice plants, cold storage, etc.

## Practical steps towards development

The Bureau of Fisheries and Aquatic Resources (BFAR) has launched the Expanded Fish Production Programme to develop the fishing industry. One of the strategies is directed towards an improvement in fish utilization. Efforts will be concentrated on elimination of wastage in processing, marketing and distribution and on earning and saving foreign exchange through the development of export products and import substitutes.

To be able to carry out the Fish and Fishery Products Utilization Programme, the BFAR is carrying out short- and long-range research projects. Top priority studies will be those which will utilize round scads, tuna, squid, shrimp, oyster, carp, bangos etc.

The agency will establish and operate pilot demonstration processing plants in strategic areas of the country to serve as show-places to processors on the adoption of new techniques and innovation in processing. Through these plants, the agency will encourage the development of new processing establishments; this will include the establishment of fish canneries near freshwater and brackish-water fisheries to satisfy the country's demand for canned fish.

New ice plants and cold storage facilities will also be constructed in areas where fish distribution is a recurrent problem due primarily to storage problems. A scheme of assistance of quality inspection and product development will also be adopted.

To make the BFAR station laboratories and field offices fully serviceable, additional equipment and technical personnel are required. Support is also required for training in fish processing technology and for acquisition of modern equipment (for microbiological and chemical analysis); fish processing expertise is required for pilot plant operational tests.

# The influence of traditional handling methods on the quality of processed fish in Nigeria

**F. N. C. Osuji**
University of Ibadan, Nigeria

### Summary

Most of the fish produced in Nigerian freshwater systems are marketed as dried fish since there are few alternative methods of preservation for distant consumer markets. Considerable quantities are lost through insect infestation, fungal attack, bacterial decomposition and fragmentation during sorting, mixing, storage and transportation. The extent to which these losses are attributable to traditional methods adopted in the dried fish industry is illustrated and discussed.

### Résumé

La plus grande part du poisson pêché dans les eaux douces du Nigeria est commercialisée sous forme de poisson séché car il n'existe que peu de méthodes de conservation pour la vente à des consommateurs éloignés. Des quantités considérables de poisson sont perdues à cause de l'infestation par les insectes, la détérioration par les champignons, la décomposition bactérienne et la fragmentation au cors du tri, du mélange, du stockage et du transport. L'importance de ces pertes attribuées aux méthodes traditionnelles adoptées dans l'industrie du poisson séché est illustrée et discutée.

### Resumen

La mayoría del pescado que se produce en piscifactorias de agua dulce de Nigeria se comercializa como pescado seco, ya que no hay muchos otros métodos de conservación para el consumo en mercados distantes. Durante la distribución, preparación, almacenamiento y transporte, se pierden cantidades considerables, debido a plagas de insectos, infecciones de hongos, descomposición bacterial y fragmentación. Se estudia y explica hasta qué punto estas pérdidas son debidas a los métodos tradicionales empleados en la industria del pescado seco.

## Introduction

The Nigerian freshwater systems comprise principally the Niger-Benue complex, the Kainji Lake, the Nigerian portions of Lake Chad, the Delta regions of the Bendel (formerly Mid-West) and Rivers States, the Cross River and the Imo, Oshun and Ogun River Systems. Many of the inhabitants of these areas are active in fishing for considerable periods during the year. The Niger-Benue Rivers, the Kainji Lake and Lake Chad are by far the most important areas of commercial fish production in Nigeria; most of the fish marketed throughout the country are derived from them. Data on the actual quantities of fish produced are fragmentary but there are indications that these must run into almost a million tonnes annually (Table 1). The few available records also show that the country's fisheries resources are severely under utilized since most of the fish are caught, processed and marketed by individual fishermen, who are ill-equipped to handle large quantities of the commodity.

TABLE 1. *Estimated annual fish production in some Nigerian freshwater systems*

| *Freshwater system* | *Fresh weight (tonnes)* | *Estimated value at source (₦ x $10^6$)** |
|---|---|---|
| River Niger[a] | 14,300 | 3.60** |
| River Benue[a] | 9,570 | |
| Niger Delta[b] | 13,600 | 2.2** |
| Kainji Lake[a] | 18,000 | 6.8** |
| Lake Chad[c] | 30,000 | 25.0 |

*1 Naira (₦) = £0.83. (March 1976)

**Figures are probably under-estimates

Source: a: Motwani, 1970
b: Scott, 1966
c: Osuji, 1973

## Commercially important fish species

Motwani (1970) reported that, of the 160 species of fish identified in the Niger-Benue system, 44 are economically important. These include: *Alestes* spp., *Arius*, *Auchenoglanis* spp., *Bagrus* spp., *Citharinus* spp., *Citheridium*, *Clarias* spp., *Clarotes*, *Chrysichthys*, *Clupisudis*, *Distichodus* spp., *Eutropius*, *Gymnarchus*, *Gnathonemus*, *Hyperopisus*, *Hydrocynus*, *Mormyrops* spp., *Mormyrus* spp., *Lates*, *Protopterus* spp., *Schilbe*, *Synodontis* spp., and *Tilapia* spp. The fish species in the Kainji Lake are very similar to those listed above except that, according to Turner (1971), the Citharinidae (especially *Citharinus citharus*) tend to dominate the catch in most seasons of the year.

In Lake Chad, the species are also much the same as in the Kainji and the Niger-Benue complex but the individual fish tend to be much larger than those in the other areas. In the Delta region, Scott (1966) reported the following as the most important fish species:

Characins: *Hydrocyon, Alestes, Citharinus, Distichodus*
Barbs: *Labeo, Barbus, Barlins*
Catfish: *Eutropius, Schilbe, Bagrus, Chrysichthys, Melapterus, Heterobranchus, Clarias*
Snoutfish: *Mormyrus, Mormyrops, Gymnarchus*
Razorfish: *Notopterus, Zenomystus,*
Clupeidae: (Pellonula)
Sailfins: *Polypterus, Calamoichthys*
Lungfish: *Protopterus*
Cichlids: *Tilapia, Hemichromis, Pelmatochromis*
Snakehead: *Ophiocephalus, Osteoglossidae, Heterotis*
The Nile/Niger Perch, *Lates.*

## Fish preservation

Fish preservation is a crucial aspect of fisheries commerce in Nigeria, especially because the high, usually prevailing, temperatures cause rapid deterioration of the fish. Only a negligible proportion of the fish caught in the rivers and lakes of Nigeria is marketed fresh; the quantity ranges from an estimated 5% in the Lake Chad district to approximately 15% in the entire Niger-Benue systems. By far the greater proportion is preserved by smoking or sun drying.

In the Niger Delta region, as well as in most of the Niger-Benue and Kainji Lake areas, smoke drying in kilns is preferred. However, in the Lake Chad district, where wood is relatively scarce and air temperatures are remarkably high for prolonged periods, sun drying is prevalent.

The traditional techniques adopted in fish processing in the Lake Chad and Kainji districts have been described by Osuji (1975 and 1976) but a few pertinent features will be mentioned here. In smoke drying, fish may be treated whole or cut into fairly large chunks. The kilns used in smoking fish in many areas are of fairly uniform construction, except that, in the Kainji district, they often incorporate chambers for post-smoking storage.

In the Lake Chad district, the smoked product has a moisture content of 32 to 47% and, therefore, still needs to be further subjected to sun drying. In the Kainji region, however, the fish may be kept in the post-smoking compartment away from the direct effect of heat and smoke until it is required for the market. Mildly smoked fish (moisture content approximately 35%) are common in the local markets in Shagunu, Kainji district, but re-smoking is generally necessary in the case of fish for distant consumer markets.

'Banda' (Hausa for dried/charred fish) is the main product from the Lake Chad district and accounted for over 96% of the total fish weight originating from this area in 1971. 'Salanga' (sun dried fish, mainly *Alestes* spp.) is also produced but is usually for local consumption among the Kanuris of the region. In the preparation of 'banda', the fish are cut into small, roughly cubical chunks and burnt with a grass fire. The charred product is left in the sun and wind, for periods ranging from four days to several weeks, to dry to moisture content levels of approximately 15% before storage.

## Fish quality

The quality of 'banda' produced in the manner just described is generally low; the product is usually dark brown or black, often with a tarry odour. Apart from the possibility of insect infestation, the fish usually become contaminated with ashes, sand and other foreign particles. However, 'banda' is usually of a hard consistency and its keeping quality is good. Consequently, it accounts for a large proportion of the north-south dried fish trade in Nigeria.

Smoke dried fish are highly relished in Nigerian traditional diets and it is unlikely that an acceptable substitute will be found in the near future. When properly handled, smoked fish are as good as any other form of fish and the chances of contamination during processing are low. Moreover, the total nutritional value is not significantly diminished by the smoking processing itself (Munro and Morrison, 1965). However, considerable losses are incurred at various stages from the landing of fish to their marketing. There are few reliable estimates available but it is reckoned that 30 to 50% of the fish processed at Lake Chad is lost by the time the fish arrive at Maiduguri for onward transportation to the consumer markets in the Southern States. The main sources of these losses are discussed briefly.

### *Fungal attack*

Insufficiently dried fish (moisture content approximately 40%), especially at the processing location, are prone to fungal infection, principally from the non-specific *Penicillium* spp. and *Aspergillus* spp. The exact impact of this factor on the entire trade is uncertain but substantial quantities of fish are usually discarded during drying due to fungal growth.

### *Bacterial decomposition*

Both smoked and sun dried fish may deteriorate early in storage as a result of bacterial action under the warm conditions that prevail in the fish processing areas. However, the losses due to putrefaction of sun dried fish ('salanga'), which are, therefore, generally unsuitable for

TABLE 2. *Insect infestation and moisture content of selected dried fish from various locations*

| *Location* | *Fish* | *Moisture content %* | | *Infestation condition* | |
|---|---|---|---|---|---|
| | | *Range* | *Mean* | *Type* | *Density* |
| Kainji Lake: | | | | | |
| Yelwa (market) | *Tilapia* | 31.1–46.6 | 37.5 | – | – |
| Shagunu (drying site) | *Citharinus* | 33.3–35.6 | 34.8 | – | – |
| Shagunu (market) | *Lates* | 28.2–30.0 | 29.1 | – | – |
| Lake Chad: | | | | | |
| Malamfatori (drying site) | 'Banda' | 32.8–47.3 | 40.3 | Diptera | ** |
| Baga (drying site) | 'Banda' | 10.6–21.2 | 15.0 | Dm,N | *** |
| Baga (warehouse) | 'Banda' | 10.4–19.4 | 15.2 | Dm,N | *** |
| Markets: | | | | | |
| Maiduguri | 'Banda' | 8.4–18.3 | 14.0 | Dm,N | *** |
| Kano | *Synodontis* | 16.6–21.2 | 19.0 | Dm | * |
| Jos | 'Banda' | 10.5–17.5 | 14.2 | Dm,N | ** |
| Ilorin | *Synodontis* | 12.2–17.5 | 15.11 | Dm,N | ** |
| | *Tilapia* | 11.1–13.2 | 12.4 | Dm | * |
| Ibadan | *Clarias* | 12.3–16.2 | 14.5 | Dm,N | *** |
| | *Heterotis* | 8.7–15.5 | 13.3 | Dm,N | *** |
| | *Citharinus* | 9.8–22.2 | 15.7 | Dm | * |
| Onitsha | 'Banda' | 10.4–18.7 | 13.9 | Dm,Da,N | ** |
| Enugu | 'Banda' | 13.8–17.7 | 14.4 | Dm,N | *** |
| | *Clarias* | 14.8–16.6 | 15.9 | Dm,N | ** |
| | *Synodontis* | 10.9–18.1 | 13.7 | Dm,N | ** |

Dm = *D. maculatus*
Da = *D. ater*
N = *N. rufipes*
* = Mild infestation, 10 pests/100 g fish
** = Moderate infestation, 19 pests/100 g fish
*** = Heavy infestation, 20 pests/100 g fish
Source: Osuji, 1973

long distance transportation and marketing, are more serious.

### *Insect infestation*

This is easily the most serious source of losses in quality and quantity of dried fish in Nigeria. Initial infestation is usually by dipteran species; maggots and puparia of calliphorid and muscid flies are common on exposed fish during early drying. These are presently replaced by dermestid and clerid beetles, the succession of infestation being directly related to changing moisture content regimes in the commodity. The two principal beetle species associated with dried fish in Nigeria are *Dermestes maculatus* and *Necrobia rufipes* although other species of *Dermestes* such as *D. ater* and *D. lardarius* have also been encountered in small numbers (Osuji, 1974 and 1975). Beetle infestation occurs during the drying stages when mated females oviposit on the fish. Consequently, the product is usually moved into storage with substantial levels of infestation, especially eggs and early instar larvae; these undergo rapid development under the warm conditions, while the fish are in warehouse storage. Several generations of the beetles may result while fish are awaiting evacuation. The larvae of both *D. maculatus* and *N. rufipes* are voracious feeders, reducing the fish to mere frass and bones within weeks. The fish which survive their ravages are often rendered unfit for human consumption by contamination with faeces and larval exuviae. Large quantities of processed fish are discarded at various stages between the drying locations and the market for this reason. Table 2 shows the typical infestation condition of dried fish specimens taken from various fish producing districts, as well as markets, throughout Nigeria; it can be seen that all these fish are liable to infestation, sometimes in the order of over 20 pests/100 g of fish. In some southern markets, pest densities of up to 180/100 g of fish have been recorded.

### *Mites*

Lardoglyphid mites (genus *Lardoglyphus*) are associated with dried fish at various stages during storage and marketing, especially during the cool, wet season. Their principal effect is to impart an unsavoury odour to the commodity and render is aesthetically unattractive to consumers.

### *Handling losses*

Dried fish are initially loaded into transit cardboard boxes and later transferred to large open warehouses, where wholesale dealers assemble processed fish purchased from various sources. Here, the fish are loaded into jute bags or crates made of dried sorghum stalks; this packaging provides little protection to the commodity during transportation or trader storage. Broken fish are vulnerable to insect damage since cracks and crevices are favoured sites for oviposition by dermestid females. The feeding activity of the resulting larvae in turn promotes further fragmentation during transportation, storage and marketing. Losses due to this factor are considerable since large quantities of fish are discarded when the commodity arrives at the southern retail markets.

## Prospects and possibilities

Methods of fish curing in Nigeria are likely to remain traditional for years to come primarily because they are simple and inexpensive. Furthermore, the product is readily accepted among the indigenous consumers. Mayer (1961) emphasized that there is little point in offering West African populations such tasteless, odourless preparations as fish flour when the same nutritional results could be obtained more cheaply by providing them with their relished dried fish.

The present methods of fish processing, however, require considerable modification to enable the fishermen to handle larger quantities and maintain reasonable quality in the product. Larger (and more) concrete kilns, better packaging and storage facilities, as well as improved transport from the fish processing locations to the market, are necessary. Since these transformations are hardly possible through the efforts of individual fishermen, it seems that the formation of co-operatives, which can attract loans from the Government and the Agricultural Credit Bank, is the only way the fishermen can expand and modernize their business. These co-operative societies will then form the basis for the standardization of techniques and the initiation of quality control. A start seems to have been made in the (former) North-Eastern State where the Ministry of Agriculture and Natural Resources gives substantial loans to co-operative societies for the kench curing of fish. Whether this project will be economically viable remains to be seen since heavily salted fish of the type produced in this way are not highly valued in Nigerian markets. However, once co-operative societies have been formed, they could be used to advantage in many directions. Collective buying and processing of the fishermen's catches will give them a stable income and aid the standardization of the product. This has been effective with other commodities in Nigeria, such as oil palm produce. Farmers sell their palm nuts to oilmills at guaranteed prices and subsequent processing and marketing are the responsibility of the Produce Marketing Board.

A Kano-based private enterprise has recently initiated the transportation of fish in refrigerated trucks from Baga, Lake Chad, to Kano, about 600 km from Maiduguri. In 1971, some 300 tonnes of fish were transported in this way. A good profit margin was reported and the venture is likely to expand. However, the market for these fish is still limited to a few supermarkets and restaurants due to the exorbitant price.

In the Kainji Lake district there are good prospects that the refrigeration of fish from New Bussa will be an economically viable proposition since ready markets are likely to be found in such cosmopolitan centres as Ilorin, Ibadan, Ile-Ife and, possibly, Lagos. However, the fish produced in the more inland rivers and lakes will continue to be marketed in a hard cured condition.

## References

**Mayer, J.** (1961) Fish proteins in nutrition and their importance in the prevention of protein malnutrition. In: *Fish in nutrition* (ed. R. Kreuzer), pp. 248, 258. *Proc. FAO Int. Conf., Washington D.C.*, 1961. London: Fishing News (Books).

**Motwani, M. P.** (1970) Fisheries investigation on Niger and Benue Rivers in the Northern Region and development of a programme of riverine fishery management and training. *FAO Report to the Government of Nigeria.*

**Munro, I. C. & Morrison, A. B.** (1965) The effects of salting and smoking on the protein quality of cod (*Gadus morhua*). *J. Fish Res. Board Can.*, **22**, 567.

**Osuji, F. N. C.** (1973) Studies on beetles infesting dried fish in Nigeria with special reference to *Dermestes maculatus* Deg. and *Necrobia rufipes* Deg. Ph.D. thesis. University of Ibadan, Ibadan.

**Osuji, F. N. C.** (1974) Beetle infestation in dried fish purchased from a Nigerian market with special reference to *Dermestes maculatus* and *Necrobia rufipes*. *Niger. J. Entomol.*, **1**, 69–70.

**Osuji, F. N. C.** (1975) Recent studies on the infestation of dried fish in Nigeria by *Dermestes maculatus* and *Necrobia rufipes* with special reference to the Lake Chad district. *Trop. Stored Prod. Inf.*, **29**, 21–32.

**Osuji, F. N. C.** (1976) The dried fish commerce in Nigeria: observations on methods of processing storage and marketing in relation to pest damage. *Niger. Food*, **XLI** (1), 3–18.

**Scott, J.** (1966) Report on the Fisheries of Niger Delta Special Area. *Niger Delta Dev. Rep.*

**Turner, J. L.** (1971) The fish population of the newly impounded Kainji Lake in Nigeria. *J. West Afr. Sci Assoc.*, **16**, 49–53.

# Dried fish production in Sri Lanka

**K. Sachithananthan**
Department of Fisheries, Sri Lanka

## Summary

Almost 10 per cent of the fish landed in Sri Lanka is dried. This paper lists the species of fish which are dried and outlines the methods used for drying and storage. The results of poor handling and storage are discussed and related to the results of sand content analysis and faecal bacteria examination of the dried product.

## Résumé

Environ 10 pour cent du poisson pêché à Sri Lanka est séché. Cet article énumère les espèces de poissons qui sont séchés, et décrit les méthodes utilisées pour le séchage et le stockage. Les conséquences d'une manipulation et d'un stockage déficients sont discutées en relation avec les résultats de l'analyse du contenu en sable et de l'examen des bactéries fécales du produit séché.

## Resumen

Casi el 10 por ciento del pescado recogido en Sri Lanka se somete a proceso de secado. En este artículo se da una relación de las especies de pescado que se someten a dicho proceso y se describen brevemente los métodos utilizados para el secado y almacenamiento. Se discuten los resultados de una manipulación y almacenamiento inadecuado, relacionándolos con los resultados del análisis del contenido en arena y del examen de bacterias fecales del producto seco.

## Introduction

Sun drying is the most convenient and cheapest form of fish preservation in Sri Lanka. Dried fish, a term used to denote both salted and unsalted dried fish, are a traditional part of the Sri Lankan diet. Also, dried fish are the cheapest form of concentrated and preserved fish protein available.

## Production

Nearly 10% of the total wet fish landings in Sri Lanka is converted into dried fish. Although all the species caught in the coastal and inland waters of Sri Lanka are used in the preparation of dried fish, the smaller sized fish, which are caught in the shore seine nets, are the major constituent in the total production of dried fish. Table 1 gives a list of the seven coastal districts which produce dried fish and their contribution towards the total dried fish production. The dried fish produced in Sri Lanka, amounting to approximately 5,000 tonnes annually, provide merely 10% of the total requirement of dried fish in the country; the balance requirement is imported.

TABLE 1. *Coastal districts producing dried fish*

| *District* | *% of total dried fish production (Average 1961–1970)* |
|---|---|
| Jaffna | 32 |
| Mannar | 19 |
| Kalmunai | 17 |
| Mullaitivu | 14 |
| Puttalam | 13 |
| Batticaloa | 3 |
| Trincomalee | 2 |

Source: Department of Fisheries, Sri Lanka

## Varieties

For the purpose of collection of statistics, the fish caught in Sri Lanka are divided into eight groups. Table 2 gives the eight different groups and their percentage contribution to the total production of dried fish in Sri Lanka. The species which are commonly dried are given in Table 3.

TABLE 2. *Percentage contribution of the different species to the total production of dried fish and the percentage wet fish converted into the dried form*

| *Species* | *% Contribution (average 1961–70)* | *% Wet fish converted to dried fish* |
|---|---|---|
| Shore seine variety (small): | | |
| Herring, sardine, anchovy etc | 61.5 | 22 |
| Sharks and skates | 14 | 11 |
| Rockfish | 9 | 6 |
| Horse mackerel | 5 | 7 |
| Shore seine variety (large): | | |
| Mackerel, ribbon fish, wolf herring etc | 3 | 6 |
| Blood fish | 0.3 | 0.2 |
| Spanish mackerel | 0.2 | 0.5 |
| Other varieties: | | |
| Crustaceans, cephalopods etc | 7 | 9 |

Source: Department of Fisheries, Sri Lanka

TABLE 3. *Locally produced dried fish species generally available in the market*

| *Scientific name* | *Common name, English* | *Common name, Sinhala* | *Common name, Tamil* |
|---|---|---|---|
| *Scoliodon* sp. | Shark | Mora | Chura |
| *Amphotistius* sp. | Ray | Maduva | Thirukai |
| *Kowala coval* | White sardine | Suthusoodaya | Vellai Choodai |
| *Sardinella albella* | Short bodied sardine | Soodaya | Choodai |
| *Sardinella* sp. | Sardine | Yak salaya | Salai |
| *Amblygaster sirm* | Trenched sardine | Hurulla | Kirimeen salai |
| *Ilisha elongata* | Slender shad | Puvalaya | Puvalai |
| *Dussumieria acuta* | Common sprat | Thondaya | Thondai |
| *Gonialosa manminna* | Gizzard shad | Koiya | Koi meen |
| *Anchoviella indica* | Indian anchovy | Halmassa | Nethali |
| *Thrissocles* sp. | Anchovy | Lagga | Tholi |
| *Chirocentrus dorab* | Wolf herring | Kattuvalla | Vallai |
| *Tachysurus* sp. | Catfish | Anguluva | Keleru |
| *Hemiramphus* | Half-beak | Moralla | Mural |
| *Exocoetus* sp. | Flying fish | Piyamassa | Paravai meen |
| *Sphyraena* sp. | Sea pike | Jeela | Jeela |
| *Mugil* sp. | Grey mullet | Godeya | Manalai |
| *Lates calcarifer* | Perch | Modha | Koduwa |
| *Therapon* sp. | Perch | Kili | Kitchan |
| *Megalaspis cordyla* | Scad | Kiralava | Vangadi |
| *Alectis indica* | Indian thread-finned trevally | Kannadi parava | Kannadi Parei |
| *Selaroides leptolepis* | Scad | Spura parava | Churaparai |
| *Caranx* sp. | Horse mackerel | Parava | Parei |
| *Caranx* sp. | Scad | Guruparava | Parei |
| *Chorinemus lysan* | Talang leatherskin | Kattava | Katta |
| *Leiognathus* sp. | Pony fish | Karalla | Karel |
| *Otolithus* sp. | Jewfish | Pannawa | – |
| *Drepane punctata* | Spotted batfish | Pasinthiya | Painthi |
| *Tilapia mossambica* | Tilapia | Japan Batta | Japan meen |
| *Siganus* sp. | Spinefoot | Ohrava | – |
| *Trichiurus savala* | Small headed ribbon fish | Savalaya | Savalai |
| *Rastrelliger kanagurta* | Indian chub mackerel | Kumbalawa | Kumbala |
| *Katsuwonus pelamis* | Skipjack | Balaya | Shoorai |
| *Scomberomorus commersoni* | Spanish mackerel | Thora | Arekula |
| *Brachirus orientalis* | Oriental sole | Madiya | Madi |

## Processing methods

Dried fish are mainly produced by three traditional methods in Sri Lanka. The quality and sanitary conditions could be improved by altering or modifying the prevalent practices of producing dried fish.

### *Dry curing*

Smaller varieties, including the Indian anchovy, which are most popular with consumers are caught in shore seines and are dried without salting. The fish are washed in water after landing and are spread on the sandy beaches; only rarely are palm leaf woven mats used for

TABLE 4. *Sand content in dried fish*

| *Species* | *Length of fish after drying (cm)* | *Weight of fish after drying (g)* | *Sand content (as % of weight)* |
|---|---|---|---|
| *Leiognathus* sp. | 7.0 | 1.9 | 10.0 |
| *Anchoviella indica* | 7.6 | 1.3 | 14.9 |
| *Sardinella albella* | 11.4 | 8.2 | 1.9 |
| *Dussumieria acuta* | 13.6 | 12.8 | 2.9 |
| *Sardinella* sp. | 13.8 | 13.3 | 7.5 |
| *Amblygaster sirm* | 16.9 | 34.0 | 2.9 |
| *Tilapia mossambica* | 22.8 | 54.8 | 5.3 |
| *Sphyraena* sp. | 34.8 | 120.0 | 4.3 |

this purpose. The fish are left for two to three days of sun drying on the beach. During rainy weather, they are left under shelter during the night.

### *Wet salt curing*

Smaller fish caught in the coastal and inland waters are cured by the wet salting process. In this process, the whole fish is soaked for about 12 to 24 hours in saturated salt solutions, contained in a wooden barrel or small boat hull. To enable effective penetration of salt, slits are cut transversely across the body before soaking. After the soaking period, the fish are taken out of the container, washed in ordinary sea water and spread evenly on the sandy beaches or on mats for four to six days. Penetration of salt is quicker in this process. A small amount of water leaches out from the fish during salting.

### *Dry salt curing*

Larger varieties of fish are dressed and salt is sprinkled over the outspread inner surfaces, on which shallow incisions have been made lengthwise to allow penetration of salt; the excess salt is sometimes washed away. The fish are laid out on sand or on mats for sun drying for periods of seven to eight days. These larger varieties are handled carefully during drying.

## Packing and storage

The dried fish are packed in 'chippam' (a bag made of woven coconut palm leaf) or in jute woven gunny bags and are placed in storerooms. The relative humidity in the dried fish producing districts (dry zone area) is generally low except during the short rainy season. However, dried fish stored in the wet zone areas tend to absorb moisture, become soft and rancid, and mould growth may occur. Moreover, this type of packing and storage is not sufficient to prevent insect infestation.

## Sand content

Traditionally produced dried fish contain sand as they are generally dried on the beaches; the percentage of sand is high in the smaller varieties. Table 4 gives an indication of the sand content of some of the dried fish produced in Sri Lanka.

## Faecal contamination

The beaches in Sri Lanka are subject to defecation by people living nearby; hence, any product coming into contact with the sand is subject to faecal contamination. All the varieties of dried fish produced locally showed the presence of *Escherichia coli* Type 1. The level of the coliforms present varied with the size, the smaller fish having a high count and the larger ones a low count. The coliform contamination in a number of species of dried fish is given in Table 5.

TABLE 5. *Presence of faecal coli in dried fish*

| *Species* | *Coliform count per g sample* | E. coli *Type 1* |
|---|---|---|
| *Kowala coval* | 4 | * |
| *Sardinella albella* | 13 | * |
| *Sardinella* sp. | 1 | * |
| *Dussumieria acuta* | 2 | * |
| *Chirocentrus dorab* | 8 | * |
| *Selaroides leptolepis* | 5 | * |
| *Rastrelliger kanagurta* | 9 | * |
| *Katsuwonus pelamis* | 11 | * |
| *Scomberomorus* sp. | 8 | * |

**E. coli* present

## References

**Department of Fisheries, Sri Lanka.** (1961–1970) Annual Administration Reports of the Director of Fisheries, Sri Lanka.

# Conservation par fumage de quelques poissons Guyanais de lagune (Siluridés)*

**H. Durand**

Institut Scientifique et Technique des Pêches Maritimes, France

## Summary

Experiments were carried out on two species of marine Silurides (*Arius luniscutis* and *Arius albicans*) to investigate the preparation of salted and smoked fillets. These fish are popular in the area and are smoked traditionally but an improved product is required.

The fish were filletted, lightly brined and hot smoked (40 minutes at 35°C, 40 minutes at 70°C and 50 minutes at 85°C) in a mechanical kiln. The yield after smoking was estimated and the products were vacuum wrapped and stored at 2–4°C. Quality changes were determined during storage by organoleptic and chemical means and the fillets were found to have an acceptable shelf life of 3 weeks. The paper concludes by considering the possibility of establishing a small industry based upon this new product.

## Résumé

Des expérimentations sont effectuées sur deux espèces de Silurides marins (*Arius luniscutis* et *Arius albicans*) pour étudier la préparation des filets salés et fumés. Ces poissons sont populaires dans la région et sont fumés traditionnellement, mais on désire une amélioration du produit.

Le poisson est mis en filets, légèrement saumuré et fumé à chaud (40 minutes à 35°C, 40 minutes à 70°C et 50 minutes à 85°C) dans un four mécanique. Le rendement après le fumage est estimé et les produits sont enveloppés sous vide et conservés à 2–4°C. Les variations de qualité sont déterminées pendant la conservation par des moyens organoleptiques et chimiques, et il est mis en évidence que les filets ont une durée de conservation acceptable de trois semaines. La communication pour terminer, traite de la possibilité d'établir une petite industrie basée sur ce nouveau produit.

## Resumen

Se llevaron a cabo experimentos sobre dos especies de Siluridos marinos (*Arius luniscutis* y *Arius albicans*) para investigar sobre la preparación de filetes salados y ahumados. Estos peces son populares en la zona y los ahuman tradicionalmente, pero se requiere mejorar el producto.

El pescado se partió en filetes, se trató ligeramente con salmuera y se ahumó en caliente (40 minutos a 35°C, 40 minutos a 70°C y 50 minutos a 85°C) en un horno mecánico. Se calculó la producción después del ahumado, y los productos se empaquetaron al vacío y se almacenaron a 2–4°C. Se determinaron los cambios cualitativos durante el almacenamiento por medios organolépticos y químicos, y se llegó a la conclusión de que los filetes tenían una duración de almacenamiento aceptable de tres semanas. El artículo concluye considerando la posibilidad de establecer una pequeña industria basada en este nuevo producto.

## Introduction

Les siluridés sont des poissons fort répandus au monde, principalement dans les eaux douces. Il existe cependant des espèces à caractère marin espèces que l'on trouve assez fréquemment dans la zone intertropicale.

Les premiers essais que nous avons effectués ont porté sur deux espèces de siluridés, abondants sur les côtes de la Guyane française: *Arius albicans* encore appelé machoiron blanc, et *Arius luniscutis* ou machoiron jaune. Ils ont été pêchés au mois de mars, sur le littoral des Iles du Salut. Le machoiron blanc que nous avons utilisé, mesure environ 50–60 cm et a un poids après éviscération d'environ 2 kg. Les machoirons jaunes peuvent atteindre 0,90 m à 1,30 m et peser de 5 à 10 kg pièce, également éviscérés.

Chez ces deux espèces, comme chez beaucoup de siluridés marins, la partie antérieure à la nageoire dorsale est recouverte de plaques osseuses. Les dents, petites, acérées et nombreuses, sont groupées également sous forme de plaques à la machoire inférieure ainsi que sur toute la voûte palatale. Ces espèces vivent dans des eaux saumâtres, dont la salinité varie de 2 à 25%. On les trouve sur tout le littoral guyanais où les fonds sont constitués de vase molle: mangrove, legune et même estuaire à des profondeurs n'excédant pas 20 m. En effet les rivières de cette région ayant d'importants debits, la dessalure des eaux littorales est assez accentuée. En periode de fortes pluies, ces poissons quittent les estuaires où l'eau peut devenir totalement douce. Inversement dans les zones lagunaires les poissons ne pénètrent pas dans le marais, surtout en période sèche où la teneur en sel est trop élevée. Ils s'agglutinent aux goulets d'écoulement entre la mer et le marais où ils se nourrissent de crevettes. Il faut noter que ces poissons carnivores, très voraces sont parmi les principaux prédateurs des jeunes crevettes *Penaeus*.

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*An English translation of this paper is available from the Tropical Products Institute.

Le mode de vie des machoirons conditionne une des principales techniques de pêche: la pêche a la courtine. La courtine est un filet fixe, vertical, fixé entre deux piquets parallèlement à la plage, la concavité tournée vers le rivage. Les captures s'effectuent au jusant, dans la zone de balancement des marées. De chaque courtinier (bateau d'environ 15 m) partent 2 à 3 pirogues de 5 m. Les pêcheurs descendent alors ramasser le poisson à la main. Ce type de pêche présente de bons rendements, mais reste limité en raisen de sa pratique pénible, les pêcheurs étant enfencés dans la vase jusqu' à mi-corps.

Les machoirons blancs et jaunes représentent environ 25% des apports totaux de Guyane. La pêche se pratique de mars à novembre. Les apports de machoirens, pour l'ensemble des pêcheurs et des techniques de pêche (courtine, ligne de fond . . . .) sont d'environ 150–180 t par an, près de la moitté étant due aux courtiniers. Ce poisson est très apprécié en Guyane et jusqu'aux Antilles où il se vend assez cher. Il est également salé ou fumé de façon très artisanale, par des pêcheurs nomades se déplaçant le long du littoral avec leurs installations. Il existe un commerce d'exportation vers le Surinam, commerce qui reste assez incontrôlable. Enfin, dans plusieurs pays, des essais d'élevage ent été effectués la croissance rapide des siluridés s'y prêtant assez bien.

## Essais effectués

Les poissons, reçus éviscérés ont été étêtés, filetés puis légèrement saumaurés (30 minutes en saumure saturée). Les rendements obtenus figurent dans le Tableau 1.

TABLEAU 1.

| | *Machoiron jaune* | | | *Machoiron blanc* | | | |
|---|---|---|---|---|---|---|---|
| Poids entier (kg) (vidé) | 5,6 | 4,65 | 6,5 | 1,95 | 1,65 | 2,1 | 1,97 |
| Poids étêté (kg) | 3,65 | 3 | 4,2 | 1,35 | 1,1 | 1,4 | 1,35 |
| Rdt étêtage % | 65 | 64,5 | 64,5 | 69 | 67 | 67 | 68,5 |
| Poids de filets (kg) | 2,75 | 2,29 | 3 | 1,05 | 0,86 | 1,03 | 1,05 |
| Rdt/entier % | 49 | 49 | 46 | 53 | 52 | 49 | 53 |
| Rdt/étêté % | 75 | 76 | 71 | 77 | 78 | 73 | 77 |

En ce qui concerne le machoiron jaune, les parties ventrales ont été comprises dans le poids des filets. Elles sont en effet très importantes et représentent ensemble environ 60–70% du poids d'un filet.

Les filets et parties abdominales ont alors été fumées à chaud dans un fumoir mécanique, selon le processus suivant: 40 min à 35°C, 40 min à 70°C et 50 min à 85°C. Le fumage à chaud a été choisi dans une première étape afin de se rapprocher des conditions climatiques rencontrées en Guyane. Les rendements au fumage ont donné les résultats suivants (Tableau 2).

TABLEAU 2.

| | *Machoiron jaune* | | | *Machoiron blanc* | | | |
|---|---|---|---|---|---|---|---|
| Poids avant fumage (kg) | 2,8 | 2,37 | 3,03 | 1 | 0,85 | 1 | 1,02 |
| Poids après fumage (kg) | 2,41 | 2 | 2,62 | 0,84 | 0,68 | 0,82 | 0,82 |
| Rdt fumage (/filet) | 86 | 84 | 86 | 84 | 80 | 82 | 80 |
| Rdt total (/entier) | 43 | 43 | 40 | 43 | 41 | 39 | 41,5 |

Après fumage et refroidissement, les filets ont été emballés sous vide, en sachets de polyamide, et stockés à basse température (2–4°C).

## Conservation

La durée de conservation a été estimée tout d'abord par les analyses sensorielles, et par des dosages d'azote volatil, de triméthylamine et de l'indice thiobarbiturique (TBA). La composition de la matière première a été établie sur le poisson entier après décongélation (Tableau 3).

TABLEAU 3.

| | *Machoiron jaune* | *Machoiron blanc* |
|---|---|---|
| Eau % | 76,4 | 77,4 |
| Graisse % | | |
| /poids humide | 1 | 1 |
| /poids sec | 4,2 | 4,5 |
| Azote total g % g chair | 2,87 | 2,88 |
| Azote volatil mg 1% g chair | 16,0 | 11,8 |
| Trimethylamine mg % g chair | 4,73 | 2,98 |
| Indice TBA mg malonald./kg | 0,15 | 0,15 |

Les filets de machoirons fumés ont une saveur très délicate et très agréable. La texture est tendre sans être molle. Les parties ventrales du machoiron jaune presentent les mêmes caractéristiques, mais bien qu'ayant subi les mêmes traitements, sont beaucoup plus salées. Après une dizaine de jours de conservation, on observe dans ces parties ventrales le développement d'une saveur doucêatre, légèrement altérée et qui s'intensifie assez rapidement. Les filets quant à eux ont une texture un peu plus sèche après 15 jours, mais restent consommables jusqu'à environ 3 semaines.

Les résultats organoleptiques se trouvent confirmés par les mesures concernant l'azote volatil (Figure 1). On

Figure 1
Dosage d'azote volatil (volatile nitrogen determination)

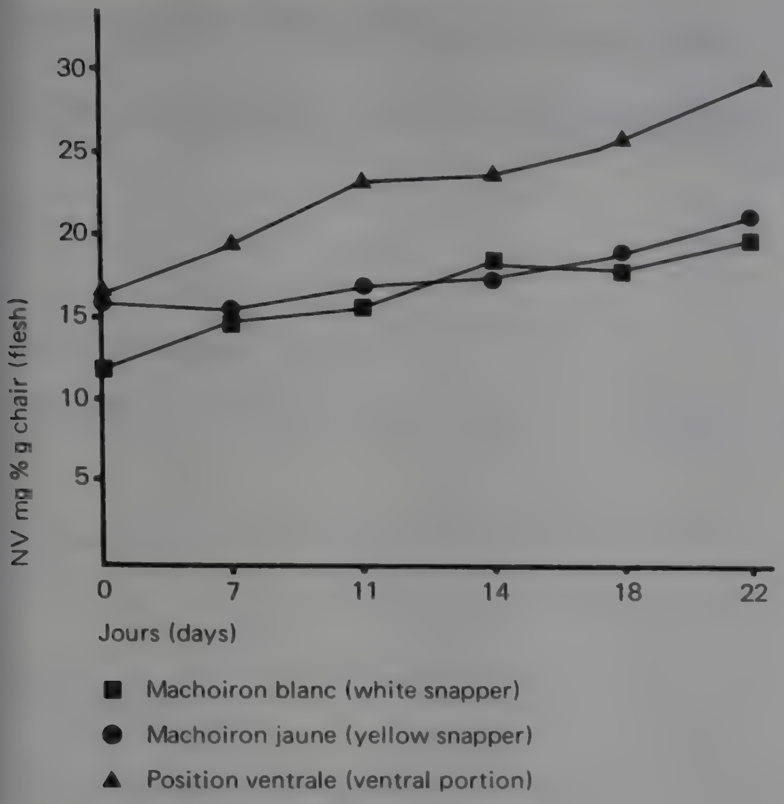


Figure 2
Dosage de trimethylamine (trimethylamine determination)

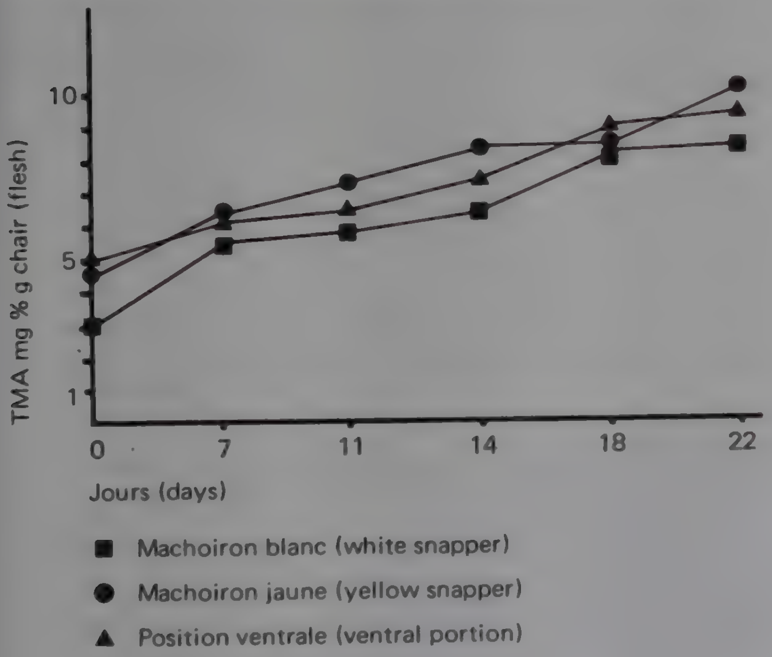
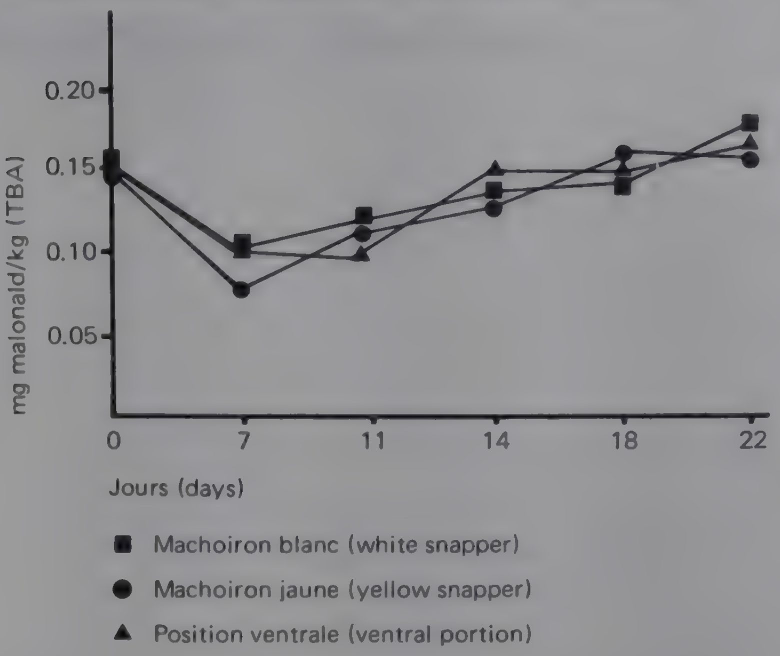


Figure 3
Mesure de l'indice thiobarbiturique (thiobarbituric index)



s'aperçoit en effet qu'on atteint des valeurs importantes dans les parties ventrales entre le 7ème et le 11ème jour, valeurs qui pour les filets ne s'observent qu'a partir du 20ème jour. Par contre les teneurs en triméthylamine, si elles deviennent importantes au bout de trois semaines ne montrent pas de différences entre les trois produits (Figure 2). Il en est de même pour l'indice TBA, qui en outre n'atteint pas de valeurs élevées, le poisson utilisé n'ayant qu'une faible teneur en graisse (Figure 3).

## Conclusion

Ces premiers essais ont confirmé que les siluridés étudiés se prêtent fort bien au fumage, et donnent des produits de très bonne qualité. La durée de conservation pourrair être augmentée en intensifiant le salage et le fumage. Les présents essais ont été menés pour tenir compte des tendances actuelles des consommateurs français préférant des produits moins salés et moins fumés qu'autrefois.

Il y a donc possibilité, en augmentant les captures, de trouver, grâce à ces espèces un moyen de créer une industrie de transformation dans ce département, industrie alimentant le marché intérieur.

Une autre éventualité, qui pourra faire l'objet d'essais futurs, est la conservation du produit fumé puis congelé sur place, pouvant peut être permettre un commerce avec des pays voisins.

# Design of a commercial dehydration plant and economics of production

**P. K. Chakraborty**
Central Institute of Fisheries Technology, India

**Summary**

This paper deals with the design and fabrication of a one ton tunnel drier for the dehydration of fish and includes two diagrams showing the details of the drier and the dehydration plant. An attempt has been made to estimate the economics of production of dehydrated fish: the cost of producing one kg of dried fish is Rs5.

**Résumé**

Cet article traite du projet et de la fabrication d'un tunnel de séchage pour la déshydration d'une tonne de poisson et présente deux diagrammes donnants les détails de l'usine de déshydratation. Un essai a été fait pour l'estimation des caractères économiques de la production de poisson déshydraté dont le prix de revient est de Rs5 par kg.

**Resumen**

Este artículo trata del diseño y la fabricación de un tunel de secado de una tonelada para la deshidratación de pescado, e incluye dos diagramas con los detalles de la planta deshidratadora. Se han intentado calcular los aspectos económicos de la producción del pescado deshidratado, que suponen 5 rupias por kg.

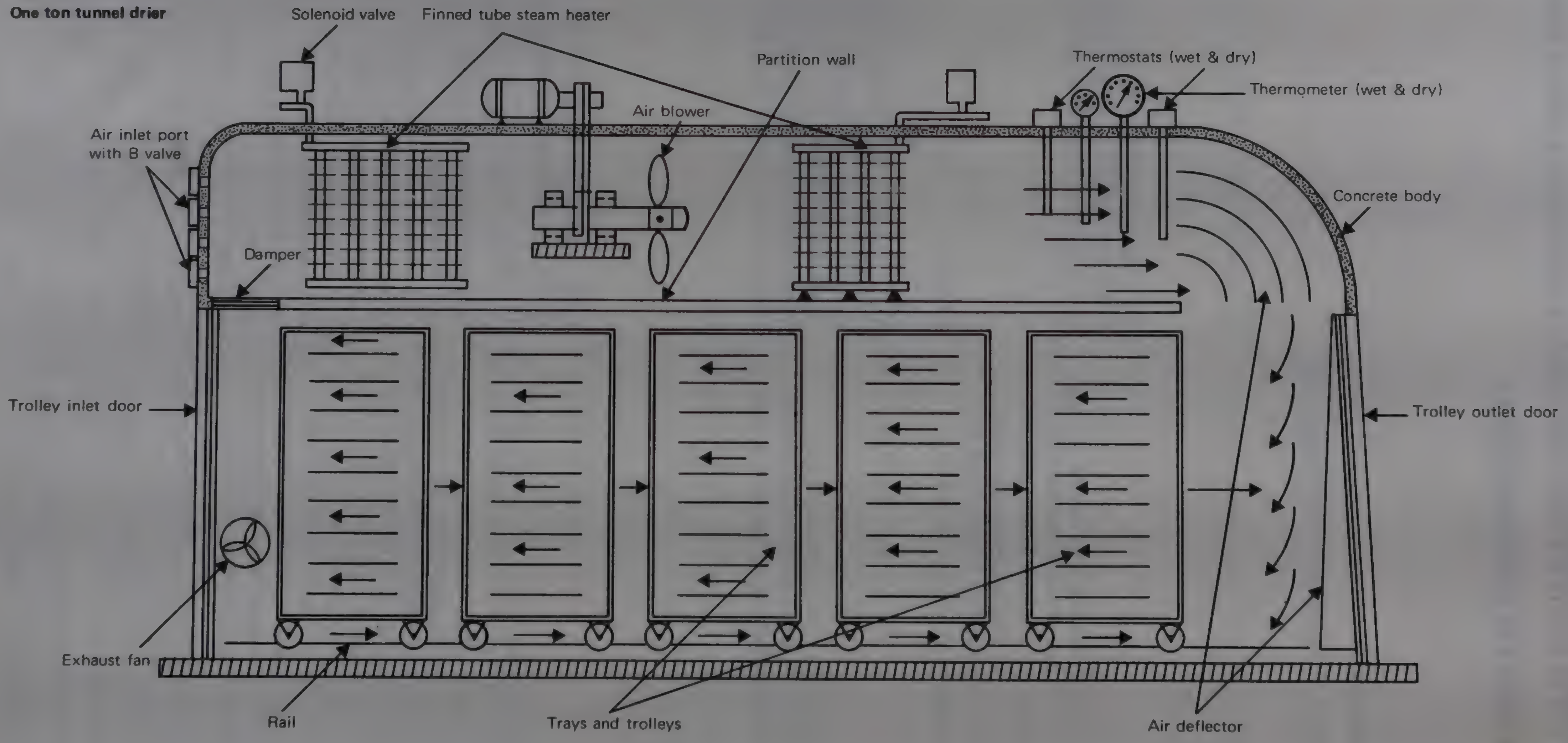
## Introduction

Fish is perhaps the cheapest source of animal protein of high nutritive value. The protein content of fish varies between 14–22% and is comparable to that obtained from land animals. Moreover, marine fish provide unlimited quantities of protein at much less effort and expenditure than from land animal sources. Even though India has a long coastline and large quantities of fish are landed every year, the per capita consumption of fish is very low compared to the world average. This is because most of these fish are landed in coastal areas far away from consuming centres, transportation and preservation facilities. Consequently a large portion of the catch becomes spoiled and unfit for consumption unless it is preserved by sun drying. In India, more than 40% of the total catch is processed by simple sun drying. The majority of the dried product is consumed internally or is exported to countries such as Sri Lanka and Burma.

Sun drying has several disadvantages. The product is invariably contaminated with pathogenic bacteria, sand and dirt, and contains a high percentage of moisture which affects the storage life. Sun drying is dependent on the weather and is very slow. A high quality product is therefore difficult to prepare and a commercial unit cannot be established using simple sun drying.

The drawbacks of sun drying can be overcome and a good quality product can be prepared by modern methods of artificial dehydration under controlled conditions of temperature, humidity and air velocity. Much of the earlier work on the mechanical drying of lightly salted cod and Cambodian fish was carried out by Legendre (1955 and 1961). The effects of temperature, relative humidity, air velocity etc on the drying rate were discussed and he also described the design of a commercial drier for fish in Cambodia. In India, Probhu *et al.* (1963), Swaminathan (1964) and Balachandran (1969) conducted some pioneering research on artificial dehydration of some of the locally available fish, mainly to standardize the drying conditions using a laboratory tunnel drier. The results were very encouraging, it was therefore decided that a commercial drier, for the large scale production of dehydrated fish, should be designed and also that the economics of production should be studied. Considering a particular fish landing and bearing in mind the total investment, a one ton per day plant was thought to be a reasonable size upon which to base the study.

**Figure 1**
**One ton tunnel drier**


Solenoid valve
Finned tube steam heater
Partition wall
Thermostats (wet & dry)
Thermometer (wet & dry)
Air inlet port with B valve
Air blower
Damper
Concrete body
Trolley inlet door
Trolley outlet door
Exhaust fan
Rail
Trays and trolleys
Air deflector

## Theory of drying and design consideration

The amount of moisture that can be carried away per kg of drying air increases rapidly with the rise of temperature (Legendre, 1962); drying should, therefore, be carried out at the highest permissible temperature (without adversely affecting the quality of the product). The surface temperature of the fish is considerably lowered at the beginning of drying due to the evaporative cooling effect (van Arsdel *et al.*, 1964). This permits the use of higher temperatures at the beginning but, as observed by Probhu (1963) and Balachandran (1969), at a temperature above 50°C cooking of fish takes place.

Another factor to be considered is the reheating and recirculation of the drying air. This is very important since it allows for regulation of the humidity and, secondly, it reduces the heat requirements of the drier and consequently the cost of the drying process. Humidity plays an important role in the drying of protein material such as fish; increasing the humidity reduces case hardening. The wet bulb temperature rises at each reheating of the recirculated air and, by adjusting the amount of recirculation, it is possible to obtain the desired humidity inside the drier without any external humidification.

Other considerations in the design of a fish drier are the air velocity, the tray load and the material for construction of the drier body. A higher air velocity results in faster drying but this involves more equipment. The power requirements therefore increases, ie for mechanical blowing of air as well as for heating. Air velocity above the optimum value is obviously uneconomic and if the air velocity is too high, the fish may be moved on the trays. Similarly, the tray load also bears a relationship to the drying rate since the greater the exposed surface of fish, the faster is the drying: a single layer of fish should be placed on the drying trays. Although the material used for construction of the drier body is not related to drying rate, it is very important for design purposes. Constructional material should be cheap, should have good insulation properties and should have good mechanical strength.

Balachandran (1969) has established the optimum drying conditions for some Indian fish: a temperature of 45–50°C, a relative humidity of 55–65% and an air velocity of 100–120 m/min have been used. The tray load has been taken as 10 kg/m$^2$ using perforated aluminium trays. Reinforced concrete has been used for the drier body for the reasons described above. Most of the common fish are dried in 12–16 hours under the above conditions.

## Description of drier and constructional details

The commercial tunnel drier described in this communication, and illustrated in Figure 1, consists of a long concrete tunnel divided into upper and lower chambers. In the upper chamber two steam or electric heaters, one air blower and several instruments for controlling the air temperature and humidity are fitted. In the lower chamber five trolleys of mild steel construction are moved on rails. On the trolleys, several layers of aluminium trays containing fish are arranged on shelves. The design allows for production scheduling such that when a trolley load of fish is dried, it is moved out from one end of the tunnel and a trolley of fresh fish (undried) is pushed in at the other end. Air movement is countercurrent to the movement of trolleys for maximum efficiency in rate of drying and quality of the product. On the lower chamber an insulated door is provided at each end and two exhaust fans are fitted on the longitudinal walls; inspection doors and a central control panel for instruments are also fitted. The partition separating the upper and lower chambers does not extend the full length of the tunnel and air can circulate as shown in Figure 1. Air temperature is controlled by adjusting the bi-metallic thermostats which regulate the heaters. Humidity of the recirculating drying air is controlled by automatic regulation of the exhaust fans.

The drier has the following overall dimensions: length 7,930 mm, breadth 1,575 mm and height 3,050 mm. The walls are 152 mm thick and are divided by a partition at a height of 1,830 mm from the floor to form two chambers. The upper chamber has a cross section of 915 x 1,270 mm and the lower chamber has a cross section of 1,830 x 1,270 mm. Five trolleys (1,220 x 1,220 x 1,805 mm) made out of 37 mm standard angle iron and 15 mm flats for supporting the trays, can be accommodated in the lower chamber. These trolleys are supported on 75 mm diameter wheels and can be moved on two rails, which are laid through the entire length of the tunnel at a distance of 915 mm apart. The rails are extended out of the tunnel, as shown in Figure 2, so that the trolleys can be moved out for loading and unloading the fish. Each trolley contains 28 shelves and holds 56 trays (1,220 x 610 x 25 mm) made out of 18 swg perforated aluminium sheet (6 mm diameter holes). There are two extra trolleys for loading and unloading. A gap of 37 mm between successive trays is allowed for air flow. At each end, an insulated, air-tight door (1,295 x 1,850 x 106 mm thick) is hinged to the side wall; the one at the trolley outlet end is provided with an air reflector. Two exhaust fans of 28 m$^3$/min capacity are fitted into holes (330 mm diameter) made towards the inlet end of each longitudinal wall at 610 mm from the floor.

In the middle of the upper chamber there is an axial flow type propeller fan, driven by a V-pulley system from a motor of capacity 275–283 m$^3$/min, situated on the roof of the drier and a static head of 50 mm of water. On the suction side of the blower, a finned tube steam heater block of 6 m$^2$ heating surface (1,200 x 890 mm in cross section), made of 25 mm diameter steam tube, is fixed. On the discharge side of the blower a 4.65 m$^2$ heater block is fixed. In case of non-availability of steam, provision is also made for fitting electric heater blocks of the same geometric cross section; approximately 45 kw are required for the suction side and 30 kw for the discharge side. For air inlet, six 152 mm diameter holes are made on the wall above the trolley inlet door; each hole is fitted with a manually operated butterfly valve. The wall above the trolley discharge door is curved to deflect the air from the blower in the lower chamber. Instruments to control the temperature and humidity of the air before it enters the lower chamber are fitted as shown in Figure 1. The two flexible tube dial thermo-

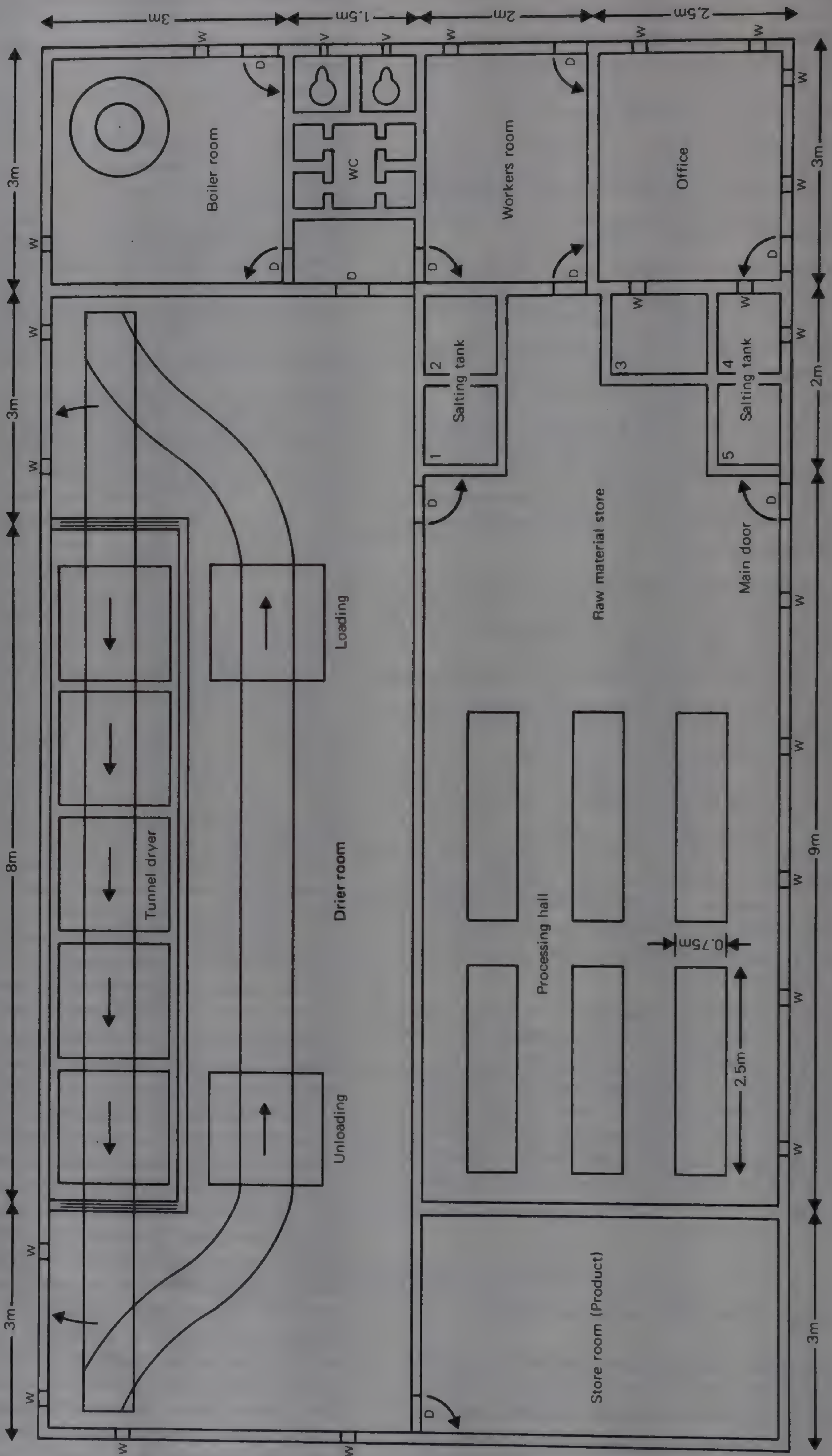

Boiler room
WC
Workers room
Office
Salting tank
Salting tank
1
2
3
4
5
Raw material store
Main door
Tunnel dryer
Drier room
Loading
Unloading
Processing hall
Store room (Product)
0.75m
2,5m
3m
1.5m
2m
2.5m
3m
3m
8m
3m
3m
2m
9m
3m
W
D
V

**Figure 2**
**Layout for fish dehydration plant**

meters are for determining wet and dry bulb temperatures and the two bi-metallic or mercury-in-steel type thermostats (wet and dry) are for controlling the temperature. The dry bulb thermostat controls the supply of steam to the heater by operating the solenoid valves fitted on the steam line or, in the case of electric heating, controls the electric heater. The other thermostat, operated (on wet bulb temperature) by covering the stem (placed in the current of drying air) with a wet cloth, controls the humidity by regulating the exhaust fan. There is a central control panel for the blower motor starter, exhaust fan regulator, pilot lamps, etc which is situated on the outside of the drier. Other instruments such as pressure gauge, safety valve, steam traps etc. are fitted on the steam line of the steam heater. The drier body is constructed using 10% reinforced steel and 1:2:4 concrete composition as a single unit but the roof has removable slabs of concrete, of convenient size, for inspection of and repairs to installations in the upper chamber.

## Handling and processing of fish for drying

Raw material for the production of dehydrated fish is generally obtained from the by-catch of prawn trawling operations, the main fishery of India. Other methods used for catching are shore seine, purse seine and gill netting operated from the smaller type of mechanized craft in inshore areas. The fish are preserved on board the vessel in baskets or wooden boxes using alternate layers of ice and fish. Fish are collected from the landing centres scattered all along the coast by the agents of processing plants and transported to the plant in insulated vans. A substantial portion of the landed fish from remote areas is transported by handcart and even on head-load for preservation by curing and sun drying.

Fish such as mackerel (*Rastrelliger kanagurta*), perches (*Nemipterus japonicus*), sprats (*Anchoviella* spp.), silver bellies (*Leiognathus* spp.), jewfish (*Otolithus* spp.), *Lactarius lactarius*, prawns, sharks, etc. are used for the production of dehydrated fish. In fact, any type of non-oily fish which cannot otherwise be utilized in the fresh condition or processed for export, can be used for drying. The production of sun dried fish has been gradually declining but a few mechanized plants, as per the design described here, have been set up to produce a high quality product based on the following process.

When fish are received in the plant they are hand sorted to remove poor quality fish and graded according to species and size. They are then washed in potable water to remove dirt and slime. Medium-sized fish such as mackerel, perches, jewfish etc., are split open longitudinally from the dorsal side along the backbone without removing the head, tail or scales; the viscera and gills are removed. The split fish are washed again to remove blood and slime and are salted with common salt, using a salt: fish ratio of 1:4. Alternate layers of fish and salt are put into a tank and left for 18 to 24 hours. Then, the salt water which forms is drained off, the fish are lightly washed to remove excess salt and allowed to drain. They are spread out on trays, inserted into the drier and dried to a final moisture content of 25–30%, under controlled conditions as described earlier. This may take 14 to 16 hours depending on the size of the fish. Small fish such as sprats are given a mild salt treatment by washing with saturated salt solution to remove slime and dried to less than 15% moisture. Large fish (eg shark) are cut into fillets, heavily salted (1 part salt : 2 parts fish) to remove urea and dried as usual. Prawns are blanched in 5% brine at boiling point for 15 minutes and dried, at higher temperatures than usual, to a 10% moisture level within 6 to 10 hours.

Dried products are packed in polyethylene bags as retail packs; several retail packs are packed in a paper master carton for despatch to interior markets. Storage life ranges from six to nine months, depending on atmospheric conditions. Distinct features of the fish produced in the drier are their superior physical condition and organoleptic quality, their longer storage life and complete lack of foul odours (which are generally associated with the conventional sun dried product).

## Estimate of the economics of production

| | | *Amount in rupees* (US $ = Rs8.85) |
|---|---|---|
| I *Total space requirement:* | | |
| (i) Total land (23 x 15m) 8.5 cents @ RS1000/cent | | 8,500 |
| (ii) Total built up area (17 x 9m) 153m$^2$ @ Rs250/m$^2$ | | 38,250 |
| | | 46,750 |
| | say | 47,000 |
| II *Machinery and equipment:* | | |
| 1. One ton tunnel drier complete with seven trolleys, 350 trays, air blower, exhaust fans, steam heaters, doors, instruments and fittings as per design | | 80,000 |
| 2. Boiler: 7 kg/cm$^2$ and 180 kg/h evaporative capacity, accessories and installation charges | | 15,000 |
| 3. Cemented washing and salting tanks of 1m$^3$ capacity @ Rs400 each | x 5 | 2,000 |
| 4. Processing tables (2.5 x 0.75m) with aluminium top @ Rs500 each | x 6 | 3,000 |
| 5. Platform balance of 100 kg capacity @ Rs2,500 | | 2,500 |
| 6. Well, pumpset and overhead tanks | | 4,000 |
| 7. Heat-sealer for polyethylene bags | | 3,500 |
| 8. Buckets, tubs, knives etc | | 3,000 |
| 9. Unforeseen | | 2,000 |
| | | 115,000 |
| III *Recurring expenditure (200 days)* | | |
| 1. Fuel, water and electricity | | |
| Furnace oil 18 litres/h and 16 h/day: 57.5 tons @ Rs522/1000 litres | | 30,000 |
| Electricity: 4 kW/h and 16 h/day: 12,800 @ 10 ps/unit | | 1,280 |
| 2. Raw material | | |
| Mackerel 1 ton/day, 200 tons @ Rs1500/ton | | 300,000 |
| Salt 1:5 ratio, 40 tons @ Rs75/ton | | 3,000 |

| | | |
|---|---|---|
| 3. Labour (monthly basis) | | |
| Plant manager @ Rs800/month | | 9,600 |
| Plant supervisor @ Rs500/month | x 2 | 12,000 |
| Boiler man/mechanic @ Rs450/ month | x 2 | 10,800 |
| Service benefits (10% of salary) | | 3,240 |
| Labour (daily basis) | | |
| Male workers @ Rs10/day | x 4 | 8,000 |
| Female workers @ Rs7/day | x 20 | 28,000 |
| 4. Packaging material (polyethylene bags) 1 kg/bag, 100,000 bags @ 20 ps/bag | | 20,000 |
| 5. Wastage and unforeseen | | 4,000 |
| | | 428,920 |
| | say | 429,000 |

*Fixed capital*

| | |
|---|---|
| Land and building | Rs 47,000 |
| Machinery and equipment | Rs115,000 |
| | Rs162,000 |
| Working capital | Rs 81,000 |
| Total capital | Rs243,000 |

*Cost of production*

| | | |
|---|---|---|
| Cost of raw material and labour etc | | 429,000 |
| Interest on total capital at 15% per year | | 36,450 |
| Profit on working capital @ 20%/year | | 16,200 |
| | | Rs496,950 |
| | say | Rs500,000 |

Assuming 50% yield containing 25–30% moisture in the final dried product

Cost of production of one ton of finished product = Rs5,000
= Rs5/kg

## Discussion

The main feature of the design of this drier is the simplicity of construction and operation. The tunnel is constructed in concrete which was chosen for its properties of insulation and mechanical strength and the cost advantage. The height of the tunnel is 1,830 mm, so that a man can easily walk through while pushing the trolley. The trolleys are made to move on rails to prevent them from touching the sides of the tunnel, and the rail system is such that the trolleys can be moved to loading and unloading points without much effort. All installations such as heaters, blower, instruments, etc, are in the upper chamber where they do not interfere with the movement of trolleys. Hygiene and cost considerations were taken into account in choosing a suitable material for the trays.

The drier has been designed for semi-continuous operation; trolleys loaded with raw fish can be pushed in at one end and trolleys of dried fish can be removed from the other end. This saves time and labour costs whilst increasing the capacity and reducing the heat load. The control system is very simple and reliable. Controlling the humidity by regulating the recirculation of drying air is more economical when compared with conventional systems of humidification. Although the production costs given here are based on steam heating, it has been found that these costs are less if the drier is operated on electricity, provided it is available at a reasonable rate. However, if the drier is operated alongside a canning plant, steam heating will be more economical.

## Acknowledgements

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## References

**Balachandran, K. K.** (1969) An accelerated method of hot air drying of fish. *Fish Technol.*, **6** (2), 124–128.

**Balachandran, K. K. & Bose, A. N.** (1965) The dehydration of prawns in tunnel driers. *Fish Technol.*, **2** (1), 126–130.

**Legendre, R.** (1955) The artificial drying of lightly salted codfish. *J. Fish. Res. Board Can.*, **12** (1). 68–74.

**Legendre, R.** (1961) Artificial drying of Cambodian fish. *J. Fish. Res. Board Can.*, **18** (1), 147–162.

**Prabhu, P. V., Swaminathan, M., Venkataraman, R. & Bose, A. N.** (1963) Investigations on dehydration of some commercial fish in India. *IPFC Curr. Affairs Bull.*, No. 37, 1–12.

**Swaminathan, M.** (1964) Design of a half ton dehydrator for fish. *Fish Technol.*, **1** (1), 76–79.

**Van Arsdel, W. B. & Copley, J. M.** (1963) *Food dehyration.* Westport, Connecticut, USA: AVI Publishing Co., Vol. I: 185 pp; Vol. II: 121 pp.

# The canning of fish in the tropics

**V. Perovic**
FAO, Institut des Pêches, Morocco

### Summary

The author briefly describes the fish canning industry with special reference to canned products in tropical countries. In particular, the problems of handling of fish before canning and during the technological operations are discussed. Processes for the canning of small pelagic species, tuna and tuna like fish, crustaceans and canned minced products are also described.

The paper includes schemes for four different canned products and a table with data concerning production of canned fish in the tropics.

### Résumé

L'auteur décrit brièvement la fabrication des conserves de poisson et spécialement les produits mis en conserve dans les pays tropicaux. Il est question, en particulier, des problèmes de manipulation du poisson avant la mise en conserve et au cours des opérations techniques. Des processus pour la mise en conserve de petites espèces pélagiques, thon, poissons ressemblant au thon, crustacés et produits hachés et mis en conserve sont décrits.

Cet article comprend des schémas concernant quatre produits différents mis en conserve et un tableau avec les données sur la production du poisson mis en conserve dans les régions tropicales.

### Resumen

El autor describe brevemente la industria conservera de pescado haciendo especial referencia de los productos enlatados en países tropicales. Se analizan en particular los problemas de la manipulación de pescado antes del enlatado y durante las operaciones tecnológicas. Se describen también tipos diferentes de procesos technológicas para el enlatado de pequeñas especies pelágicas, atunes y peces afines, crustáceos y productos picados enlatados.

El artículo incluye esquemas technológicos para cuatro productos enlatados diferentes y una tabla con datos relativos a la producción de pescado enlatado en los trópicos.

### Introduction

The preservation of perishable foods by means of heating in air-tight containers is a comparatively recent development. The author of this technique was Nicolas Apert, who, in 1810, edited the famous 'L'art de conserver', the first publication concerning the canning of foods.

In 1820, the first fish were canned in the United States (Tressler and Lemon, 1960). Lobsters, oysters and other seafoods were canned in New York City and offered on the market (Stansby, 1963). Since that time, canned fish products have made a large impact on the world market. There was an explosion of canned food production at the beginning of the twentieth century with the introduction of seaming machines and the general trend has subsequently been to increase the production of canned fish. In 1973, 10.6% of the total world catch was used for canning (Table 1).

Although canning is one of the most expensive ways of preserving fish, canned fish products have had, and will continue to have, a bigger and bigger market. Thanks to characteristics such as durability, ease of storage and preparation, and the large variety of products, canned fish are utilized by many different consumer groups. The military, hospitals, schools, individuals in large urban centres and individuals far away from supply centres regularly consume canned products.

The advantages and disadvantages of canning as a method of preserving fish are well described in published literature and will not be reviewed here. However, it is necessary to

TABLE 1. *Disposition of world catch for canning*

| | 1958 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|---|---|---|
| Total world catch (tonnes × $10^6$) | 33.0 | 60.4 | 63.9 | 62.7 | 69.8 | 69.7 | 65.6 | 65.7 |
| Total canned (tonnes × $10^6$) | 3.0 | 5.3 | 5.6 | 5.8 | 6.2 | 6.6 | 6.8 | 7.0 |
| (% total world catch) | 9.0 | 8.8 | 8.7 | 9.2 | 8.9 | 9.5 | 10.4 | 10.6 |

Source: FAO, 1972, 1973 and 1974

stress that a big effort is now being made to solve some of the chronic problems in canning (especially manpower and packaging materials). The mechanization and automation of canning lines and new packaging materials based on aluminium and plastic are opening a new era in canning generally, as well as in the canning of fish (Widmer, 1971; Perovic, 1974; Clement, 1975).

Although the fish canning industry is more developed in the industrialized countries of the northern hemisphere, fish canning factories are located all around the world, either near the fishing grounds or far away from the resources but near to large consumer centers. Morocco, a developing country, is the largest producer of canned sardines (*Sardina pilchardus* Walb) in the world (FAO, 1973). Moroccan canneries are located close to the coastal fishing areas from which they get their raw materials.

The canning of fish (one of the most complex methods of fish processing) is not very well developed in the tropics (Table 2), although the tropical oceans are rich in fish suitable for canning. Some of these fish are exploited by developed countries for their own fish processing industries. Italy, for example produces more than 30,000 tonnes of canned tuna annually; most of the tuna is caught in the Atlantic, frozen and then transported to the Italian canneries.

Although it is the opinion of some authors (Disney *et al.*, 1974) that canning is likely to become less common in both the tropical and colder areas of the world, some developing countries in the tropics and subtropics are making great efforts to promote the fish canning industry. For example, in 1973, Morocco produced 3,600,000 cartons of 100 club cans and exported 2,875,000 cartons, mostly sardines (Anon, 1974). A similar situation exists in Brazil and Mexico but these two countries sell a larger proportion of their locally canned fish products on their own market (FAO, 1973; Da Costa, 1974). In order to promote the growth of the canning industry in the tropics, the following criteria must be satisfied:

- a regular supply of a large quantity of suitable fish at reasonable price
- adequate manpower
- an adequate supply of packaging and other auxiliary materials (salt, oil etc)
- infrastructure (transportation facilities, energy, water)
- market for the finished products

Once canning has been chosen as a way of preserving fish, special attention must be given to the technology of processing. Da Costa (1974) reported on the types of fish which are processed in the developing world and concluded that sardines and sardine-like fish, tuna and tuna-like fish and different types of molluscs are the most profitable species for canning. Based on this conclusion, the technology of fish canning described in this paper is divided into four groups: sardine and sardine-like fish, tuna and tuna-like fish, crustaceans (shrimps) and canned fish spread products. Special attention is given to the handling of the fish prior to processing.

## Handling of fish

It is well known that the first step in processing fish starts on board the fishing vessel immediately after capture and before rigor mortis. The initial treatment of the fish after capture is of prime importance for all types of preservation as well as for canning. The most important operation after capture is to chill the fish; this practice is valid both for tropical fish and for fish from temperate or cold water.

Although data are lacking on chilling tropical fish, it seems (Disney *et al.*, 1974) that tropical fish stored in ice have a longer shelf life than temperate- or cold-water species. Bykov (1974) states that some fish from the Indian ocean do not differ significantly in their technological properties from those of other areas and that rigor mortis sets in within the first hour of capture. Cann (1974) found that shrimp caught in the waters of Thailand and the Indian ocean have a storage life of up to 16 days, if properly handled and stored in ice.

The technology of chilling fish on board fishing vessels depends on the type, size and quantity of fish as well as on the distance between fishing grounds and processing plants. Ice and refrigerated or chilled sea water are two media which are most commonly used for chilling fish.

The method of packing fish is important especially for small fish which could easily be mechanically damaged or bacteriologically spoiled. The most common type of boxes for handling small fish destined for the cannery are returnable ones. Fish boxes, in use on the fishing vessel and in the factory, are generally made of wood, aluminium or plastic. The requirements for perfect fish boxes have been specified (OECD, 1970). Although data on the use of fish boxes in the tropics are lacking, some investigators have found that plastic (Souness, 1973) is a suitable material. The dimensions of fish boxes, especially depth, must be carefully studied. Sometimes similar fish require completely different methods of handling and different types of fish boxes. For example, the herring (*Clupea harengus*) can be

TABLE 2. *Production of canned fish in the tropics in 1973*

| Country | Total catch | Available for canning | Percentage of fish available for canning | Net product canned | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | | Names of main species | Quantity per species | Total canned main species | |
| | (tonnes x $10^3$) | | | | (tonnes x $10^3$) | | |
| AFRICA | | | | | | | |
| Angola | 467.2 | 2.5 | 0.53 | Miscellaneous | 2.2 | 2.2 | |
| Ivory Coast | 51.1 | 3.5 | 6.84 | Miscellaneous | – | 4.8 | |
| Senegal | – | – | – | Sardines | 0.4 | | |
| | | | | Skipjack | 5.8 | | Data for 1972 |
| | | | | Yellowfin | 6.8 | 13.0 | |
| NORTH AMERICA | | | | | | | |
| Costa Rica | 10.8 | 6.7 | 62.0 | – | – | – | |
| Cuba | 126.1 | 4.0 | 3.17 | Tuna | 0.5 | | |
| | | | | Bonito | 0.4 | | Data for 1971 |
| | | | | Miscellaneous | 1.0 | 1.9 | |
| Mexico | 457.8 | 57.2 | 12.49 | Sardines | 60.3 | | |
| | | | | Tuna | 8.5 | | Data for 1972 |
| | | | | Mackerel | 3.1 | | |
| | | | | Other | 2.9 | 74.8 | |
| Nicaragua | 11.0 | 2.6 | 23.63 | – | – | – | |
| SOUTH AMERICA | | | | | | | |
| Brazil | 419.1 | – | – | Sardines | 34.7 | 38.6 | Landing, data for 1971 |
| | | | | Miscellaneous | 3.9 | | Data on canned products for 1972 |
| Ecuador | 106.6 | 19.8 | 18.57 | Thread herrings | 4.3 | | |
| | | | | Skipjack<br>Yellowfin | 3.7 | 8.0 | Data for 1971 |
| Peru | 2,219.3 | 64.8 | 2.92 | Herring | 14.3 | | |
| | | | | Bonito + skipjack | 10.5 | | |
| | | | | Mackerel | 2.2 | | |
| | | | | Horse Mackerel | 0.5 | | |
| | | | | Other | 0.1 | 27.6 | |
| Venezuela | 162.3 | 14.1 | 8.70 | Herring<br>Sardines<br>Anchovies | 21.9 | 21.9 | |
| ASIA | | | | | | | |
| India | 1,958.0 | 15.9 | 0.81 | Lobster | | | |
| | | | | Shrimp | | | |
| Indonesia | 1,230.4 | 18.2 | 1.47 | *Chanos chanos* | | | |
| | | | | *Sardinella* | – | – | Data for 1971 |
| | | | | *Katsuwonus* | | | |
| | | | | *Pelamis* | | | |
| Pakistan | 214.1 | 9.0 | 4.20 | Shrimp | – | – | |
| Singapore | – | – | – | Miscellaneous | 2.9 | 2.9 | |

Source: FAO, 1972; Da Costa, 1974; FAO, 1974.

packed with ice and in boxes of 30 litres capacity (20 cm high), whereas the sardine (*S. pilchardus*) must be handled more carefully; packed in between two layers of ice in much shallower boxes.

The method of chilling fish in refrigerated sea water is used by many boats from the northern hemisphere which fish in the tropics. Atlantic sardines caught from 36°N to 34°S (*Sardinella aurita, S. eba. S. maderensis and S. cameronensis*) held in cooled sea water at 0°C remain in rigor mortis for 48 hours (Bidenko *et al.*, 1974). Keeping fish in chilled sea water in tanks or containers is a relatively new technique for bulk transport of fish. As far as the writer is aware this method has not yet been introduced to the tropics. This method of handling may give good results but, before it is introduced on an industrial scale, a series of experiments should be carired out with the species of fish to be handled. Superchilling, as a method of preserving fish, gave good results with fish from temperate and cold waters but it appears that the use of this method in developing countries is likely to be marginal (Disney *et al.*, 1974).

Freezing of fish (as a method of preservation) before canning is recommended only when canning plants are far from the fishing grounds. Tuna, however are generally frozen before canning. The problems of freezing tuna were the subject of study for many years. The brine freezing system used on tuna purse seiners is the most common method of freezing (Scotland, 1973), but the new freezing method for tuna, known on the market under the name 'Confreeze' and 'Mini-Confreeze system', has a few distinct advantages over the old brine system. The 'Confreeze' system uses calcium chloride brine, allowing the tuna to be frozen and held at −35°C. Tuna is vacuum-packed in plastic bags before freezing and protected by insulation (Doust, 1975a and b). The quality of tuna frozen by the 'Confreeze' method should be better than tuna frozen by the old brine system.

After arrival at the canning plant the fish must be kept cool until processing begins. This applies to both iced and frozen fish since the temperature of the processing plant may be as high as 30°C; the fish should be re-iced and placed in cold storage. The same procedure is necessary for fish arriving in containers. In all cases the fish must be kept cool until actually processed.

## Canning of sardine and sardine-like fish

According to a generally accepted definition, sardine and sardine-like fish are fish from the Clupeidae and Engraulidae families. There are many sardine species inhabiting tropical waters; some of them are canned in the tropics while others are frozen on factory boats and canned elsewhere.

There are a few different methods of canning sardines but all of them are commonly divided into six operations (Lisac and Perovic, 1961): pre-treatment (including weighing, washing, grading, nobbing and brining); packing cans; pre-cooking; filling (oil or tomato sauce) and seaming; sterilization; and final operations.

This classification could be used for other types of canned fish. Since sardines are canned traditionally in the Mediterranean area, some of the sardine canning methods originated there. Nowadays, we find the well known 'Mediterranean line' on the market, which gives excellent results in canning *Sardina pilchardus* and some of the *Sardinella* species.

Flow sheet 1 and following description outline the stages of a continuous and partly automatic sardine canning line of the 'Mediterranean' type (Perovic and Lisak, 1969). Before discussing the process, it must be stressed that first class raw material should be used for canning; only sardines which have been properly handled, iced and stored should be used. If sardines are transported to the processing plant in fish boxes, a pallet system is recommended both for the boxes with fish and for the empty boxes after discharging and washing.

Pre-treatment includes weighing, grading, nobbing, washing and brining of the sardines. The most important operations are nobbing and brining. Nobbing is done by nobbing machines which have a capacity from 70 to 400 fish per minute; the operation includes the removal of heads, viscera and tails. Vertical cutting is also a part of this operation if sardines are of a large size; the nobbing machines are adjusted to the required length of square cans commonly used for packing canned sardines. The brining process has been the subject of much discussion and it has been suggested that this operation be bypassed and an adequate quantity of salt placed directly into the cans. However, these products were found to be inferior to those which were brined. During brining, the fish are still bleeding and the skin starts to become firm; this is an important technological advantage during pre-cooking. It was also found (Anon., 1961) that the 'firmness' of the canned fish is inversely related to the degree of breakdown of the collagen in the tissue and that skin collagen in unbrined herring is 50% greater than that of brined fish during pre-cooking. Brine is generally saturated (24–25° Bé) and brining time varies from 15 to 45 minutes, depending on the size and fat content of fish. Brining equipment is made from non-corrosive materials, commonly from plastic and stainless steel. The equipment is supplied with a brine generator where the new brine is produced and old brine filtered and regenerated.

Packing is a hand operation carried out on a conveyor which has supply bands for nobbed fish, empty cans and for fish already packed in cans. During this operation sardines are classified by quality into two categories. The first automatic machines are on the market and it is expected that they will soon replace manual labour.

The 'Mediterranean' sardine canning line includes a continuous cooker for pre-cooking. This cooker usually has two sections, the first is for pre-cooking in steam at about 95°C and the second for drying in steam and hot air at about 130°C. Inverted cans with fish are placed on perforated stainless steel grills, so that steam can enter the tins and condense, and drip can flow out. The grills, with the cans, are transported through the cooker by means of two chain conveyors. The cooking operation requires from 30 to 45 minutes, depending on the size and fat content of the fish. Input and output of the grills in the cooker are usually automated.

The operation of filling (with oil and tomato sauce) and closing the cans is generally made with seaming machines which have units for coding the lids, filling and seaming. The normal capacity of a seaming machine for rectangular cans is between 60 to 70 cans per minute. As there is always oil on the can after seaming, this oil is recovered. Specially designed machines wash the cans and recover the oil by means of a decanter and separator.

The cans are commercially sterilized in hot water in horizontal autoclaves. The sterilizing temperature is 115–116°C and over pressure of 2–2.5 kp/cm². The sterilization time for 1/4 club 125 g cans sardine in oil is between 45 and 60 minutes, depending on local conditions.

Final operations include washing and drying of the cans, packing in cartons, inspection, ripening and packing in individual cartons and in cartons of 100 cans. The ripening period is not the same for all sardine species. Bidenko *et al.* (1974) found that the ripening period for Atlantic sardine is three months.

The standard Mediterranean sardine canning line has a capacity of between 6,000 and 7,000 1/4 club 125g cans per hour or about 50,000 cans per 8 hours shift.

## Flow sheet 1

### Scheme for a sardine canning line

| *Auxiliary supply* | *Process stages* | *Residue* |
|---|---|---|
| | Reception of fresh sardine in fish boxes | |
| | PRE-TREATMENT | |
| water | Weighing | |
| water | Grading | fish boxes, washing, waste water |
| water | Nobbing | heads, viscera, tails, waste water |
| water | Washing | waste water |
| salt + water = brine | Brining | used brine |
| water | Washing | waste water |
| clean empty cans | PACKING | damaged fish |
| steam, air | PRE-COOKING | condensed water, fish drip (water + soluble component, fish oil), hot air |
| | FILLING & SEAMING | |
| steam, oil or sauce | Filling with oil or sauce | condensed water, oil purification |
| lids, coding | Seaming | oil → purification |
| steam, water | Recovery of oil from cans | water + oil → decanting purification |
| steam, water | Washing of cans | waste water |
| | STERILIZATION | |
| | Basket loading | |
| steam, water | Sterilization under pressure | waste water |
| | Basket discharging | |
| | FINAL OPERATION | |
| steam, water, air, detergent | Washing and drying of cans | waste water, hot air |
| cartons | Packing in cartons | |
| | Interim storage | |
| | Inspection | damaged cans |
| pallet | Ripening-storage | |
| individual cartons | Packing in individual packages | damaged cartons |
| glue, coding material | Closing and coding cartons of 100 cans | |
| | Delivery | |

The line requires 45 to 50 workers. The consumption of energy and water for the direct work is as follows (Perovic *et al.*, 1973):

| | |
|---|---|
| Electricity | 60 kW/h |
| Steam | 1,050 kg/h |
| Water: industrial | 15 m³/h |
| potable | 1 m³/h |
| Total water | 16 m³/h |

This canning line and technological process could be adapted for canning sardine and sardine-like fishes in any type of small-size rectangular cans such as club, dingly, hansa and oval, as well as round cans of moderate capacity and height.

**Tuna canning**

Tuna and tuna-like fishes are some of the most important raw material for the fish canning industry. The tuna canning industry is very well developed, especially in countries of the northern hemisphere such as the USA, Japan and parts of Europe. The famous 'pack shapers' and 'pack formers' machines developed in USA were for many years the most sophisticated equipment for packing tuna in cans. With these machines the tuna canning industry in the USA reached the highest point of mechanization, as evidenced by the extremely large capacity of production developed. The canning line described in this paper (Flow sheet 2) is based on one of a moderate capacity which is currently available; it was developed in Europe and Japan. Using this line it is possible to produce a variety of canned tuna products such as solid pack, flakes, chunks, tuna fillets, and tuna and vegetables. These products could be packed in oil, brine or tomato sauce, in round, square or oval cans.

Pre-treatment of tuna includes thawing, cutting the body into pieces or steaks, washing and filling on stainless steel grills and trays. The thawing of tuna is generally done in running water. Barbaianov and Lemarine (1967) suggest using water at a temperature of 10–15°C. During thawing, the tuna still bleeds especially if the fish has not bled enough before freezing (blood comprises 5–7% of the body weight of the intact fish). If the tuna are frozen whole (small species), the heads are removed immediately after thawing by guilliotine and the viscera are extracted from the ventral cavity. Tuna are then cut vertically into pieces or horizontally into steaks, according to size of the cans in which the meat will be packed. After washing and placing on grills and trays, the tuna meat is ready for pre-cooking; one of the most interesting operations in tuna canning. According to Stansby (1963), the purpose of pre-cooking is to remove a portion of the natural oils, to loosen the meat from the bone and to obtain proper texture in the canned products. Tanikawa (1971) states that the purpose of pre-cooking is to coagulate the fish meat protein and to increase firmness through partial dehydration. Novikov *et al.* (1972) reported that pre-cooking is generally done to give firmness to the meat, to improve nutritional value and to improve taste and appearance.

During pre-cooking the tuna meat loses weight and the physico-chemical properties of the muscles change. It was found that tuna loses about 25% of its weight compared to the weight of frozen fish without head and viscera. Perovic and Knezevic (1971) investigated bluefin drip and found that losses during pre-cooking contained 6.04–8.71% of dry matter. They found also that total nitrogenous compounds (N x 6.25) varied between 4.96 and 7.16%; and proteins (N x 6.25) between 1.98 and 2.59%. The industry does not as yet recover drip from pre-cooking.

Pre-cooking is done in steaming chambers at a temperature of from 100–105°C. The time of pre-cooking varies between 1 and 12 hours, depending on the size and species of tuna (Stansby, 1963; Zaitsev *et al.*, 1969; Tanikawa 1971); the temperature in the middle of the meat is about 85°C. After pre-cooking, cooling and drying operations take place until a temperature of approximately 15°C is reached. This operation is generally done in open air or in cooled chambers. During cooling and drying, tuna meat looses weight. The time of cooling and drying varies between 10 and 20 hours, depending on the size of meat and cooling conditions (Zaitsev *et al.*, 1969). This operation delays the canning by one day. This technology is, of course, not to be recommended for tropical countries.

The packing operation starts with the manual separation of the skin, bones and dark meat. The packing machines (constructed in Europe and Japan) have a capacity which varies between 5,000 and 10,000 round cans per hour. Some of these machines are capable of packing fillets in club cans.

Filling with brine, tomato sauce or oil is done on the seaming machines as in the case of sardine canning. If oil is filled in the cans, salt is added to the tins before packing the meat. Seaming of round cans could be done with a machine having a capacity of 100 to 200 cans per minute; for rectangular cans the capacity is 60 to 70 cans per minute.

Sterilization, is one of the most important operations. The literature cites sterilization temperatures and processing times (pre-heating, sterilization and cooling) for different types of cans (Zaitsev *et al.*, 1969; Tanikawa, 1971) but conditions governing the processing of tuna are still being studied by many research workers. Cagna *et al.* (1973) found that sterilization conditions for tuna cans depend on the size, content and type of pack as well as on the cooling system employed and the way of cooling cans. Autoclaves used in the line discussed in this paper are of horizontal type with over pressure and are suitable for all types of cans used for tuna.

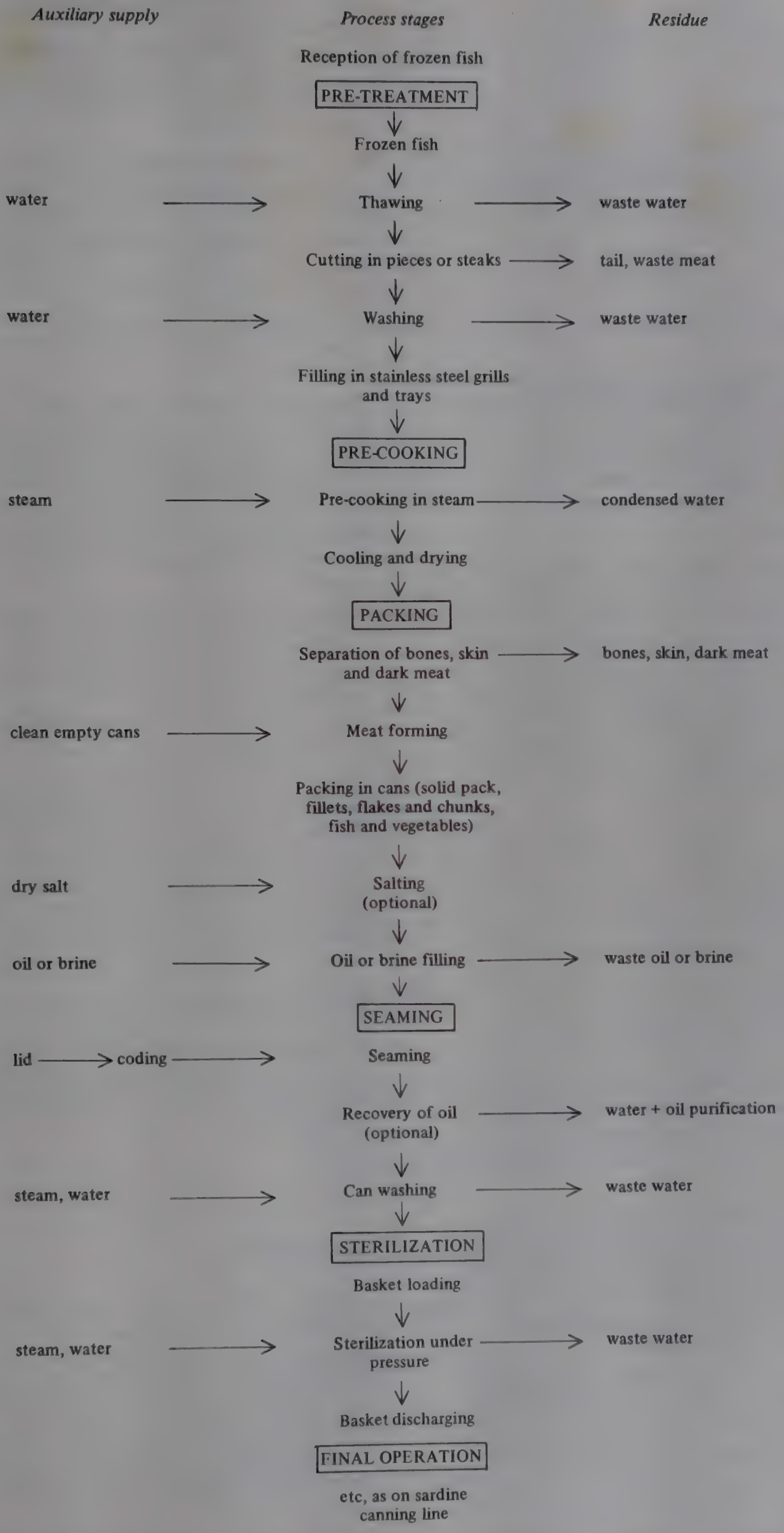
The final operations are similar to those of a sardine canning line.

The capacity of a tuna canning line is 1.5 tons of frozen tuna (yellowfin, without head and viscera) per hour. Yield is shown as follows (Perovic *et al.*, 1972):

| | | |
|---|---|---|
| Input (raw material) | | 1500 kg |
| Lost during thawing | 0.76% | |
| Lost during cutting and washing | 1.00% | |
| Lost during pre-cooking | 23.80% | |
| Lost during cooling and drying | 4.70% | |
| Skin, dark meat and bones | 12.90% | |
| Total lost | 42.16% | |
| Yield | 57.84% | |
| Output (net meat ready for packing) | | 850 kg |

## Flow sheet 2

Scheme for a tuna canning line


*Auxiliary supply*
*Process stages*
*Residue*
Reception of frozen fish
PRE-TREATMENT
Frozen fish
water
Thawing
waste water
Cutting in pieces or steaks
tail, waste meat
water
Washing
waste water
Filling in stainless steel grills and trays
PRE-COOKING
steam
Pre-cooking in steam
condensed water
Cooling and drying
PACKING
Separation of bones, skin and dark meat
bones, skin, dark meat
clean empty cans
Meat forming
Packing in cans (solid pack, fillets, flakes and chunks, fish and vegetables)
dry salt
Salting (optional)
oil or brine
Oil or brine filling
waste oil or brine
SEAMING
lid
coding
Seaming
Recovery of oil (optional)
water + oil purification
steam, water
Can washing
waste water
STERILIZATION
Basket loading
steam, water
Sterilization under pressure
waste water
Basket discharging
FINAL OPERATION
etc, as on sardine canning line

The consumption of energy and water for direct work is (Perovic *et al.*, 1973):

| | |
|---|---|
| Electricity | 60 kW/h |
| Steam (10 kp/cm$^2$) | 1,860 kg/h |
| Water: industrial | 14 m$^3$/h |
| potable | 1 m$^3$/h |
| Total water: | 15 m$^3$/h |

Manpower varies from 50 to 85 men or women. If only solid pack and chunks are produced, 50 workers are on the line; for fillet production, tuna and solid pack 85 workers operate the line.

### Shrimp canning

Shrimp is one of the most important crustaceans used for canning. Many different species of shrimps suitable for canning such as *Penaeus* spp., *Metapenaeus* spp. and *Parapenaeus* spp. are found in tropical waters. The shrimp canning industry in the tropics is export-orientated, the main importing countries being the USA, Western Europe and Japan.

The canning of shrimp has a long tradition; the USA was and still is the most important producer of canned shrimp. Modern automated lines are installed in many factories but there are still many lines, especially in the tropics, where some operations, such as peeling and deveining, are done by hand. The technology of shrimp canning differs from country to country. Flow sheet 3 presents a typical chain of operations on a shrimp canning line; in the following description some recommendations for processing shrimp will be made.

As previously stated, the shelf life of properly chilled and ice-packed tropical shrimp is 9 to 16 days. This long storage life makes it possible to capture and collect shrimp at a distance from the fishing grounds. Since damage can take place during handling and storing a serious inspection must be made. Determination of shrimp quality must be done before and during the canning operations. It is necessary to stress that a first class product can be produced only if fresh and live shrimp are used. If shrimp which have been stored for a few days in ice are used for canning, the colour of the canned meat could be greyish with a light smell of hydrogen sulphide. This is not always the rule and storage life in ice should be determined for each species and area.

Pre-treatment includes operations such as peeling, cleaning and deveining which are specific to shrimp processing. These processes are automated; machines remove the cephalothroax and shell as well as the veins from the tail. Nowadays, machines are especially designed for shrimp of small sizes.

Pre-cooking, which is similar to that for tuna, is one of the most discussed operations. Tanikawa (1971) reported that headless shrimp should be cooked in 6–9° Bé brine for 2–3 minutes, cooled, peeled, soaked in an acid solution, washed and drained before steaming. The steaming time is 15–30 minutes. Novikov *et al.* (1972) suggested boiling headless shrimp in 3% brine for 5–7 minutes. Zaitsev *et al.* (1969) reported that pre-cooking should be done in 3–4% salt solution for 6–10 minutes, or in steam for 10–15 minutes at a temperature of 95–100°C, depending on the size of the shrimp. Tressler and Lemon (1960) reported that some packers in the USA blanch shrimp in a 50° salinometer brine for 8–10 minutes if shrimps are to be canned 'wet pack', or 10–12 minutes for 'dry pack'.

After pre-cooking, cooling and drying take place. If the shrimp are not properly dried, they will stick together after canning (Tanikawa, 1971). Shrimp are generally packed in round cans protected against blackening by C-enamel lacquer and parchment paper. Dry packs must be vacuum seamed. In the wet pack, a brine solution of 2–6° Bé is added to the cans. Some authors suggest adding 4% of citric or tartaric acid to the brine (Novikov *et al.*, 1972).

Sterilization is a delicate operation due to the physico-chemical characteristic of shrimp meat. It is a common practice to use sterilization temperatures below 110°C; but if the temperature is higher than 110°C, the sterilization time is shorter than that required for other canned fish products. Barbaianov and Lemarine (1967) suggested the following sterilization for the 142 cm$^3$ round can.

> Temperature 115°C; pre-heating + sterilization + cooling = 10 + 15 + 15 min.
> Temperature 107°C; pre-heating + sterilization + cooling = 7 + 30 + 7 min.
> Temperature in the cans after sterilization and cooling should be between 35 and 40°C.

The processing time for canned shrimp, starting with the separation of ice in pre-treatment and ending with sterilization, should take a maximum of four hours (Novikov *et al.*, 1972). The yield of shrimp depends on the species, its size and the technological process employed. It is found that the net yield of tails before packing in cans varies between 20 and 32%. The final operations are similar to any other canned fish products.

Properly canned shrimp has a taste similar to fresh cooked shrimp tails, the colour of the meat is white/reddish, the liquid is colourless or light reddish, the consistency is compact and the smell is characteristic of fresh cooked shrimp. The salt content in the meat has to be between 1.5 and 2%.

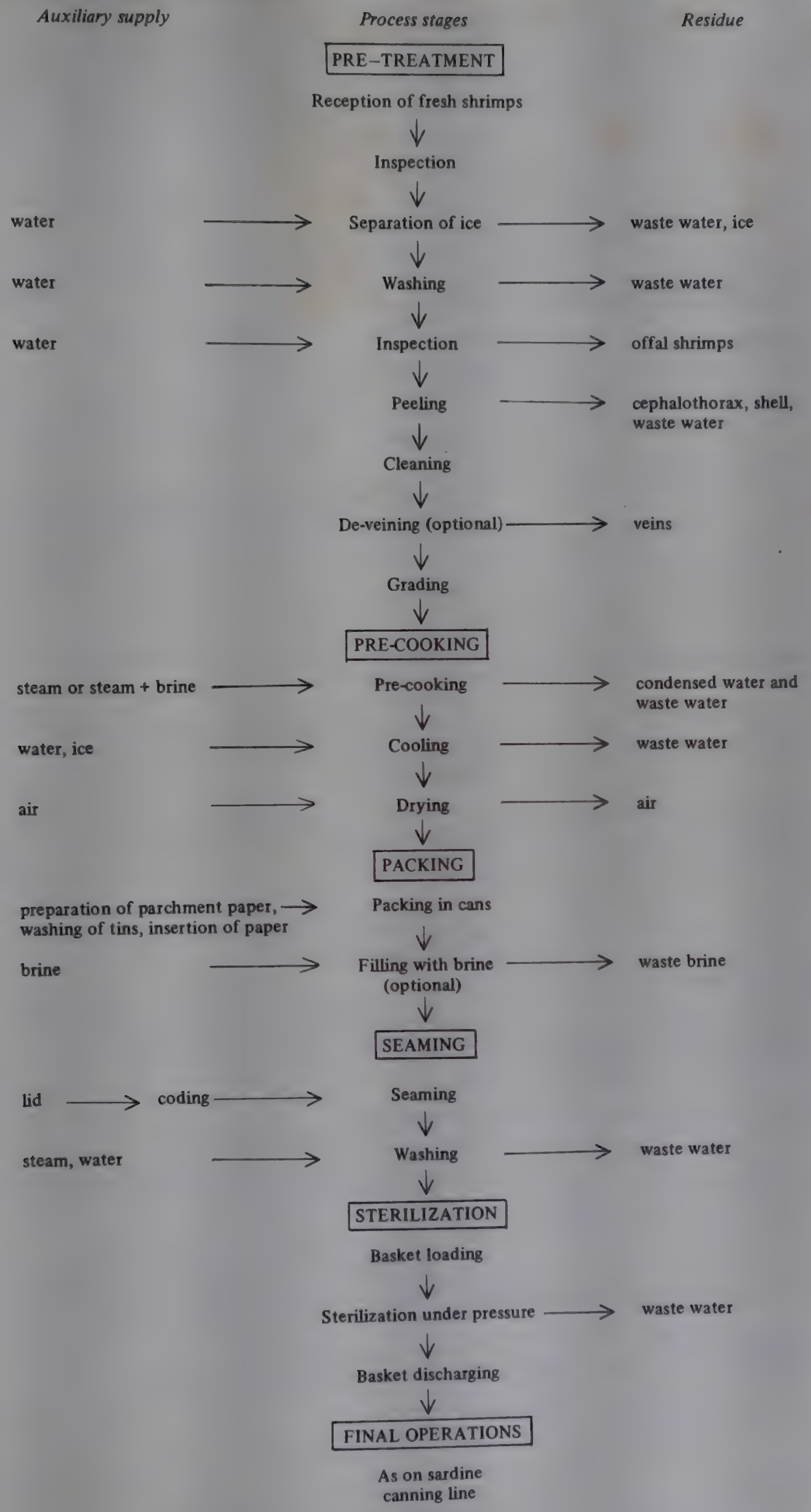
### Canned fish spread

A variety of different types of canned fish spread is produced and marketed in many developed countries. These products are generally based on raw material which was not previously or sufficiently exploited, (eg fish of a small size), filleting waste as well as different types of crustaceans. Although the raw material for fish spread is not 'the best fish', the nutritional value of this product is similar to other canned products (Knezevic, 1975).

Tropical countries have a variety of different fish, such as sardines, anchovies, mackerels, snappers, horse

Flow sheet 3

Scheme for a shrimp canning line

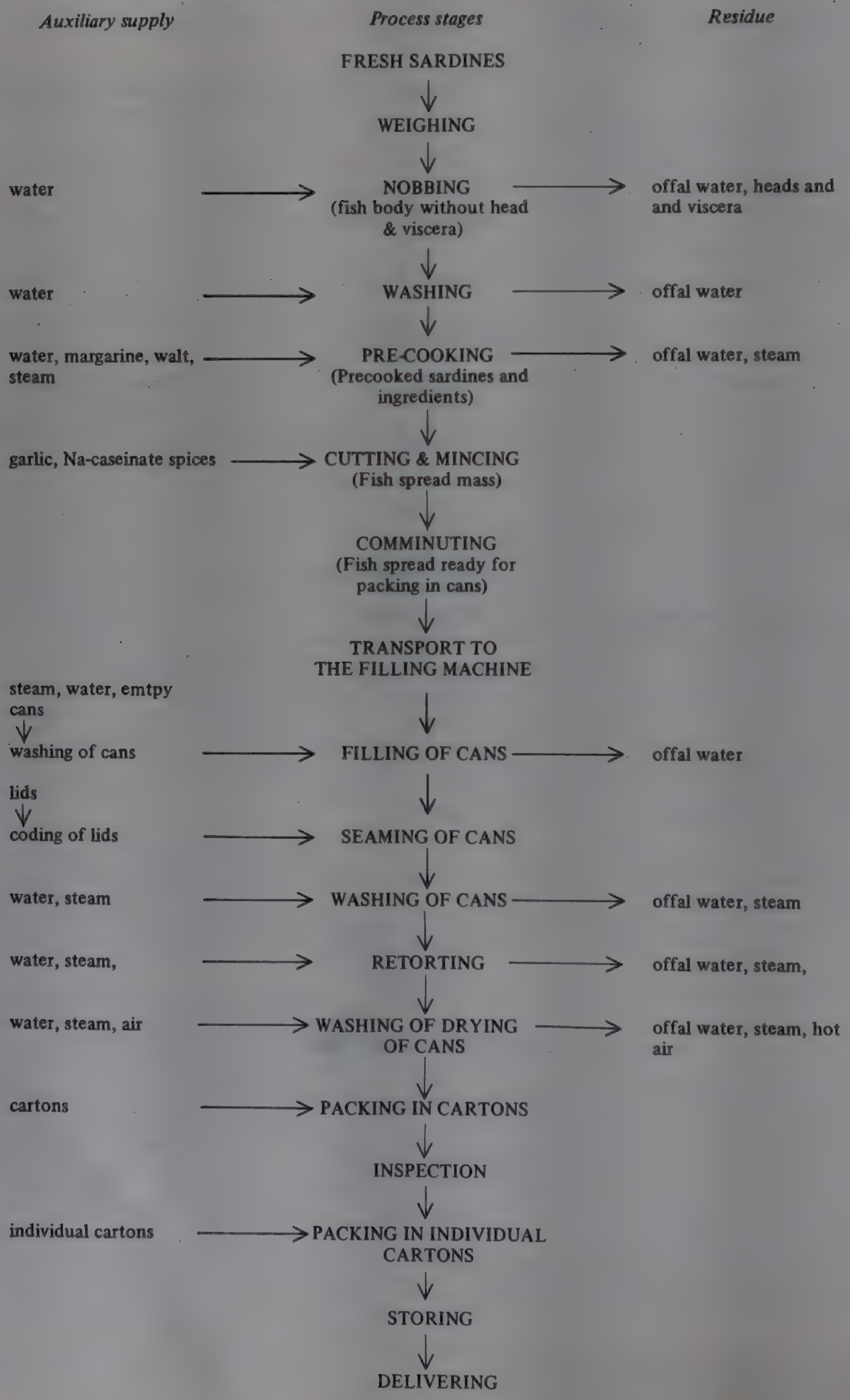

Auxiliary supply
Process stages
Residue
PRE–TREATMENT
Reception of fresh shrimps
Inspection
water
Separation of ice
waste water, ice
water
Washing
waste water
water
Inspection
offal shrimps
Peeling
cephalothorax, shell, waste water
Cleaning
De-veining (optional)
veins
Grading
PRE-COOKING
steam or steam + brine
Pre-cooking
condensed water and waste water
water, ice
Cooling
waste water
air
Drying
air
PACKING
preparation of parchment paper, washing of tins, insertion of paper
Packing in cans
brine
Filling with brine (optional)
waste brine
SEAMING
lid
coding
Seaming
steam, water
Washing
waste water
STERILIZATION
Basket loading
Sterilization under pressure
waste water
Basket discharging
FINAL OPERATIONS
As on sardine canning line

mackerel etc, suitable for the production of canned fish spread. This product could be much cheaper than the classical canned fish products as confirmed by developments during the last few years (Perovic, 1975). A few different types of fish spread are, or will soon be, marketed in some developing countries. Flow sheet 4 and the following description show a sardine spread canning line.

The fresh sardines are nobbed, washed and pre-cooked in salted water and fat for about 20 minutes. The mass of cooked fish is then loaded into a cutting machine (cutter), together with other ingredients such as tomato concentrate, sodium caseinate and spices. As the fish are processed with bones in, a colloid mill is used to reduce all particles to the size of a few microns. From the colloid mill the fish mass goes to the filling

**Flow sheet 4**

**Scheme for a sardine spread canning line**


Auxiliary supply
Process stages
Residue
FRESH SARDINES
WEIGHING
water
NOBBING (fish body without head & viscera)
offal water, heads and and viscera
water
WASHING
offal water
water, margarine, walt, steam
PRE-COOKING (Precooked sardines and ingredients)
offal water, steam
garlic, Na-caseinate spices
CUTTING & MINCING (Fish spread mass)
COMMINUTING (Fish spread ready for packing in cans)
TRANSPORT TO THE FILLING MACHINE
steam, water, emtpy cans
washing of cans
FILLING OF CANS
offal water
lids
coding of lids
SEAMING OF CANS
water, steam
WASHING OF CANS
offal water, steam
water, steam,
RETORTING
offal water, steam,
water, steam, air
WASHING OF DRYING OF CANS
offal water, steam, hot air
cartons
PACKING IN CARTONS
INSPECTION
individual cartons
PACKING IN INDIVIDUAL CARTONS
STORING
DELIVERING

machines where the spread is filled in round cans made from tin, aluminium or aluminium laminated with plastic.

Can seaming should be done by ordinary automatic seaming machines. Sterilization is recommended in over pressure autoclaves. The sterilization regime for 1/8 round cans of 100 g could be 35 minutes at 115–116°C and over pressure of 2–2.5 kp/cm$^2$. All other operations specified under 'final operations' are similar to other fish canning lines.

The capacity of the line is about 10,000 × 1/8 round 100 g cans per hour. The consumption of energy and water is as follows:

| | |
|---|---|
| Electricity | 150 kW/h |
| Steam | 880 kg/h |
| Water | 12 m$^3$/h |

The line is attended by 49 workers covering all stages from the first opration in pre-treatment to delivery from storage.

This canned sardine spread line could be used as a basis for the similar exploitation of other fish species. Existing recipes could be adapted or new recipes created according to local market habits.

### References

**Anon.** (1961) Chemical changes in herring during heat processing. In: *Annual Report, Torry Research Station Aberdeen,* 1960, pp. 22–26.

**Anon.** (1974) *La conserve de poisson du Maroc et les souse-produits.* Casablanca: Office de Commercialisation et d'Exportation, p. 28.

**Barbaianov, K. A. & Lemarine, K. P.** (1967) *Proizvdstvo ribnih konzervov,* 2nd edn. Moskva: Pischevaia Promislenost, p. 339.

**Bidenko, M., Shenderyuk, V. & Agzhitova, L.** (1974) Technology of processing of Atlantic sardine. In: *Fishery products* (ed. R. Kreuzer), *Proc. FAO Tech. Conf. Fish. Prod., Tokyo,* 1973, pp. 206–212. Surrey, England: Fishing News (Books), 462 pp.

**Bykov, V. P.** (1974) Initial treatment of some fish species caught in the Indian Ocean. In: *Fishery products* (ed. R. Kreuzer), pp. 77–81. Surrey: Fishing News (Books).

**Cagna, D., Guidi, G., Piroti, D. & Poretta, A.** (1973) Sulla sterilizazione delle conserve di Tonno all'alio e al naturale. *Ind. Cons.* (Parma). **XL VIII** (1), Jan–Mar, pp. 5–8.

**Cann, D. C.** (1974) Bacteriological aspects of tropical shrimp. In: *Fishery products* (ed. R. Kreuzer), pp. 338–344. Surrey: Fishing News (Books).

**Clement, J. M.** (1975) *L'industrie alimentaire.* Paris: Collection Genie Alimentaire, p. 123.

**Da Costa, A.** (1974). The fishery products industries in the developing world. In: *Fishery products* (ed. R. Kreuzer), pp. 81–99. Surrey: Fishing News (Books).

**Doust, J. D.** (1975a) New freezing system for tuna seiner and stern trawlers. *Fish. News Int.,* 14(10), 35–42.

**Doust, J. D.** (1975b) How Mini-Confreeze meets the needs of smaller vessels. *Fish News Int.,* **14** (11), 61–64.

**Disney, J. G., Cole, R. C. & Jones, N. R.** (1974) Considerations in the use of tropical fish species. In: *Fishery products* (ed. R. Kreuzer), pp. 329–337. Surrey: Fishing News (Books).

**FAO** (1972) *Yearbook of fishery statistics, Vol. 33, Fishery commodities,* 1971.

**FAO** (1973) *Yearbook of fishery statistics,* Vol. 35, *Fishery commodities,* 1972, p.328.

**FAO** (1974) Yearbook of fishery statistics, Vol. 37, *Fishery commodities,* 1973, p. 326.

**Knezevic, M.** (1975) Znacaj Razvoja Proizvodnje Gotove i Polugotove Hrane na Bazi Ribe. I *Kongres Proizvodnje Luedske hrane u Jogoslaviji, Novi Sad,* 10–13 September 1975, pp. 121, 125.

**Lisac, H. & Perovic, V.** (1961) *Tehnologija ribe i prerade riba.* Zagreb: Ekonomski Fakultet, p. 277.

**Novikov, V. M., Djakovskaya, E. S., & Tenyakov, A. J.** (1972) Spravochnik Tehnologa Ribnoy Promishlenosty, **IV**, (1) Moscow, Pischevaya Promislenost, p. 321.

**OECD** (1970) Packages and packaging material for fish. Paris: Organisation for Economic Co-operation and Development, p. 95.

**Perovic, V. & Lisak, D.** (1969) *Tehnoloski projekt linije za sitnu plavu ribu.* Zadr: Centar za Ribu i Privredu Mediterana, p. 73.

**Perovic, V. & Knezevic, M.** (1971) *Ispitivanje moguenosti Koristenja iscjedka ribe nastalog za vrijeme topkinske obrade.* Zadar: Centar za Ribu i Privredu Mediterana, p. 19.

**Perovic, V., Lisak, D. & Divic, B.** (1972) *Technoloski projekt linije za prerodu krupne plave ribe.* Zadar: Centar za Ribu i Privredu Mediterana, p. 62.

**Perovic, V., Lisak, D. & Divic, B.** (1973) *Idejni projekt, Mardesic Dalmatinske Tvornice Riblijih Konzervi.* Zadar: Centar za Ribu i Privredu Mediterana, p. 107.

**Perovic, V.** (1974) *Aluminium as packaging material for the fish canning industry.* Vienna: UNIDO, ID/WG.172/6, p. 11.

**Perovic, V.** (1975) *Canned sardine spread.* Casablanca: UNDP/FAO Fishery Project MOR 71/531, p. 30.

**Stansby, E. M.** (1963) *Industrial fishery technology.* New York: Reinhold Publishing Co. p. 393.

**Scotland, W. B.** (1973) The brine freezing system in tuna purse seiners. *Fish News Int.,* **12** (7), 30–34.

**Souness, J. A. R.** (1973) *An investigation of the fish box requirements for a national distribution system in Peru.* Report on FAO Fishery Project PER 535 p. 18.

**Tanikawa, E.** (1971) *Marine products in Japan.* Tokyo: Koseisho-Koscibaku Co. p. 507.

**Tressler, D. K., & Lemon, J. Mc W.** (1960) *Marine products of commernce,* 2nd ed. New York; Reinhold Publishing Co., p. 782.

**Widmer, K.** (1971) Steralcon: l'emballage multicouche aluminium/platique pour les aliments en conserve. *Schweiz. Alum. Rundsch.*, 4 (7), 15.

**Zaitsev, V., Kizevetter, J., Lagunov, L. Makarova, T., Minder, L. & Podsevadov** (1969) *Fish curing and processing.* Moscow: MIR Publisher, p. 732

# Fish handling, processing and marketing in the Lake Chad Basin (north west shores)

**N. I. Azeza**
FAO, Lake Chad Fisheries Development Project, Nigeria

## Summary

The paper reviews the fish processing industry of the north west shores of Lake Chad, including the fishing methods and the marketing channels. The various forms of processing, some of which are peculiar to the region (eg 'banda'), are described together with an outline of the developmental problems involved in upgrading the industry. Particular attention is paid to fish movements and prices and the operation of the fish trade between Lake Chad and the southern parts of the country.

A consideration of fish quality deals largely with the problems of insect infestation and the losses which arise from it. Poor transportation and packaging are also implicated. The paper concludes with a plea for a greater research effort designed to improve the quality and quantity of fish originating from Lake Chad.

## Résumé

Cette communication passe en revue l'industrie de transformation du poisson du littoral nord-ouest du lac Tchad, ainsi que les méthodes de pêche et les débouchés commerciaux. Les diverses formes de transformation, dont certaines sont particulières à la région (par exemple, 'banda'), sont décrites ainsi que les données des problèmes de développement qui se posent pour relever l'industrie. Une attention particulière est portée aux mouvements du poisson et aux prix et au fonctionnement du commerce de poisson entre le lac Tchad et les parties méridionales du pays.

A propos de la qualité du poisson on fait une large part aux problèmes d'infestation par les insectes et des pertes que ceux-ci occasionnent. Le transport et l'empaquetage dans de mauvaises conditions sont également impliqués. Cette communication plaide, pour terminer, en faveur d'un gros effort de recherches afin d'améliorer la qualité et la quantité du poisson provenant du lac Tchad.

## Resumen

El artículo revisa la industria de elaboración de pescado de la orilla noroeste del Lago Chad, incluyendo los métodos de pesca y los canales de comercialización. Se describen diversas formas de elaboración, algunas de las cuales son peculiares en la región (como, por ejemplo, 'banda'), junto con un esbozo de los problemas de desarrollo que implica la mejora de la industria. Se concede particular atención a la circulación y precios del pescado, así como a la operación del comercio de pescado entre el Lago Chad y las zonas del sur del país.

Un estudio sobre la calidad del pescado tiene que ocuparse necesariamente de los problemas de la infestación por insectos y de las péridas que ocasiona. También están implicados los defectos en el transporte y embalaje. El artículo termina con un alegato en favor de un mayor esfuerzo en la investigación destinado a mejorar la calidad y la cantidad de pescado procedente del Lago Chad.

## Introduction

The challenge which fish handling, processing and marketing in the Lake Chad Basin poses to mankind in the present century is both socio-economic and scientific. It is socio-economic because the lake and the environment surrounding it provide practically the entire food and money for the welfare of the people and it affords potential industrial sites for agriculture, fish, livestock and tourism.

The challenge is scientific because it poses great problems for research into the estimation of fish population and statistics for fishery regulation, fish handling, processing and marketing.

Fish catches in the lake vary considerably depending on the season, the type of gear used and the location. Fishing techniques have undergone reasonable changes from the old traditional fishing methods. Nylon nets, used as gill and seine nets, are now predominant, replacing the locally manufactured cotton fibres. Different net mesh sizes, ranging from 4 to 7 in are in use; sometimes, 11 to 15 in mesh nets are used.

A few 'Coffin' boats may still be seen on the water but planked canoes and double chime plywood boats (18 ft long) have been introduced. Most of these are propelled by outboard motors. The traditional 'kadei' made of papyrus stems have virtually disappeared.

Although some inshore fishermen use unbaited long lines with steel hooks and seine nets for catching *Tilapia* spp. and *Alestes* spp., most fishermen set their nets in the late afternoon and recover them next morning. Great efforts are made to recover the catch quickly to avoid decomposition of the fish, caused by the scorching heat, and possible removal by predators. During the day, the fishermen mend their nets while the women and other male helpers are involved in handling and processing the fish.

## Fish handling

The methods of fish handling employed on the lake shores need a great deal of improvement. The basic problems revolve around the distance involved between capture and processing. The distance from one island in the eastern part of the lake to the Baga site or Malamfatori shores is such that most boats come to shore between 11.00 a.m. and 1.00 p.m.; by this time, most of the fish have shed their slime and blood and other contaminants which cause spoilage. Heat accelerates virtually all reactions; consequently, the fish landed on these shores are always rancid because they have been exposed to the warm temperatures on the lake area. Before the fish are sold, fresh or processed, to customers, they are rarely well washed with clean water since there are no proper landing sites. All these factors contribute to the conclusion that fish are poorly handled in this area of the lake; this is another socio-economic problem.

## Fish processing

Fish are sold fresh, cured as 'banda', salted and sun dried or simply sun dried. Recently, *Clarias* spp. have become the predominant fish caught. They are very oily fish and the usual processing method for these is smoking while they are still relatively fresh. Some of the fish are rancid and putrified before landing; these are sun dried.

Below, a brief description of the various processed fish products prepared by the fishermen and their helpers in the islands and the northern part of the lake is given:

### *Sun dried fish*

This consisted mostly of *Lates niloticus* of two grades based on the degree of dryness. The properly dried grade was meant for long distance transport as far as the Lagos and Onitsha markets. However, since the 1973–1974 drought, *Lates niloticus* are no longer caught in the north eastern part of the lake and have now been replaced by *Hydrocynus brevis* and *Citharinus citherus. Alestes, Hydrocynus* and *Clarias* are the species of fish commonly sun dried these days. *Alestes* spp. and *Hydrocynus* spp. are sun dried as a rule but putrified *Clarias* spp. are sometimes cured after the addition of Gamalin 20, to protect against insect infestation. The fish are split open, treated and hung up for drying. Gamalin 20 is a dangerous chemical for human consumption and must be replaced by other less dangerous chemicals; pyrethrum could be considered as a substitute. Some of this 'putrified–before–sun dried' *Clarias* has a very ready local market. Local consumers prefer this type of processed fish since it adds a desirable taste to their soup.

### *Salted sun dried fish*

Due to the cost involved in procuring salt, local fishermen have not used it to any extent in the production of dried fish. Salted sun dried fish were prepared only by the fishermen who benefited from the North Eastern State's fishermen loan scheme.

### *Smoked fish*

Since firewood is scarce, smoking is much less widespread than sun drying. However, smoking, as a means of preservation of the oily fish, *Clarias* spp., and the commercially important *Gymnarchus niloticus,* is still used for the preparation of products reserved almost entirely for export markets in the southern states.

### *'Banda'*

'Banda' is prepared from large fish which have been scaled, eviscerated, cut into pieces and then sun dried for a few hours on papyrus mats. The pieces are arranged on dry grasses and covered with old mats. A fire is set on them to char the fish after which they are sun dried for about six days. These are graded and packed into sacks, ready for the Southern States' markets.

Another method of fish processing which could be carried out is chilling fish on ice before deep freezing. There is no icing of fish at present. The Lake Chad Fisheries Development Project, Baga, (a project that is being set up with the aid and expert advice of FAO/UNDP personnel) is to look at the possibilities for this valuable method of fish handling.

## Marketing

Fish marketing is active in both Baga, where the more commercial market activity is centred, and Malamfatori. At Baga and Kaniram, it is common for the middlemen to buy fresh fish from the fishermen and retail these to the consumers. Those fish, which could not be sold immediately, go for smoking or sun drying. Sometimes the fishermen arrive at the Baga and Kaniram shores with their catches already processed; these are handed over to the 'Belbelas', the people who sell the fish on commission (₦2.00* per sack or carton) to the country buyers.

### *Fish traders*

Generally, the women outnumber the men and the country buyers outnumber the consumers in most of the markets surveyed (Tobor, 1972). Women are generally seen selling dried *Alestes* spp. and *Hydrocynus* spp., sun dried fish and fried fish (including adipose fins of *Bagrus bayad* and other catfish) around Kaniram and Malamfatori. Men, on the other hand, sell mainly 'banda' and smoked fish. Country buyers often come to the markets from distant places such as Aesaram in the Gubio district, Gasamala in the Kukawa district, Gajiram in the Gajiram district and Yebi, Tuworam, Bukargujari, Kayal and Nguigni in Niger Republic.

## Fish transport

Fish from the lake are brought to the shore by canoe and are taken from the shore, by camel and donkey, to Malamfatori fish market. At Duwuri and Baga, trucks, tractors and Land Rovers go to the shores to collect loads of fish sacks and cartons, all heading to the Southern States' markets. Fresh fish are rarely transported.

The Federal Fish Census programme has established that quite a large tonnage of fish leaves the Lake Chad shores for the south. The Fish Traffic Census figures for the month of November 1975 are given in Tables 1 and 2.

These Fish Traffic Census figures clearly show Baga as the busiest place for fishing activity while Lagos, closely followed by Onitsha, is the best consumers' market for Lake Chad fish.

## Fish trade

The manner in which fresh fish are prepared, processed and packed depends, firstly, upon the species of fish and, secondly, upon the market or consumer for which they are intended. Most smoke dried fish (mainly *Clarias* spp. and *Gymnarchus niloticus*) and 'banda' find their way to the Lagos and Onitsha markets. The smelly putrified fish (*Clarias* spp.), processed by sun drying, finds a ready market among the Kanuris who live about 140 miles around the Lake Chad shores. Before the fish are sold, they are graded according to the quality and processing method.

### *'Banda'*

'Banda' is graded on the basis of size, quality of fish from which it was prepared and the degree of insect infestation. Three grades exist:

Grade I: Locally called 'white fish', it consists of large pieces made almost exclusively from *L. niloticus* and only slightly attacked by beetles and their larvae. Recently the catch of *L. niloticus* has dropped; therefore, big pieces of *Clarias* spp. and *Bagrus* spp. are now used. Grade I costs between ₦50.00 and ₦60.00 per sack.

TABLE 1. *Fish Traffic Census figures at Baga Road check-point (November, 1975)*

| *Transport* | *Weight tonnes* | *% of total weight* |
|---|---|---|
| 'Banda' from: | | |
| Baga | 1,277.511 | 81.27 |
| Alagarno | 23.391 | 1.49 |
| Abadam | 144.812 | 9.21 |
| Malamfatori | 104.007 | 6.62 |
| Metele | 9.134 | 0.58 |
| Badairi | 12.918 | 0.82 |
| Monguno | 0.241 | 0.01 |
| *Total* | 1,572.014 | 100.00 |
| 'Banda' to: | | |
| Lagos | 343.325 | 21.84 |
| Maiduguri | 63.307 | 4.03 |
| Enugu | 350.105 | 22.27 |
| Kano | 108.613 | 6.90 |
| Ibadan | 95.218 | 6.06 |
| Onitsha | 237.535 | 15.11 |
| Benin | 243.092 | 15.46 |
| Okene | 79.690 | 5.07 |
| Jos | 51.131 | 3.25 |
| *Total* | 1,572.014 | 100.00 |

TABLE 2. *Fish Traffic Census figures at N'Djamena Road check-point (November, 1975)*

| *Transport* | *Weight tonnes* | *% of total weight* |
|---|---|---|
| 'Banda' from: | | |
| Gambaru | 723.644 | 86.32 |
| Wulgo | 74.030 | 8.83 |
| Marte | 24.485 | 2.92 |
| Blankwa | 16.137 | 1.93 |
| *Total* | 838.296 | 100.00 |
| 'Banda' to: | | |
| Lagos | 121.565 | 14.50 |
| Port Harcourt | 55.808 | 6.60 |
| Onitsha | 166.727 | 19.89 |
| Maiduguri | 122.695 | 14.64 |
| Enugu | 108.291 | 12.92 |
| Okene | 168.797 | 20.13 |
| Bama | 3.418 | 0.42 |
| Benin | 43.775 | 5.22 |
| Kano | 31.781 | 3.79 |
| Jos | 15.439 | 1.84 |
| *Total* | 838.296 | 100.00 |

No lorry carring 'salanga' was checked.

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*1 Naira (₦) = £0.88 at June 1976

Grade II: Consists of a mixture of different good quality fish, small *Clarias* spp., *Bagrus* spp. and *Heterotis niloticus*. Grade II costs between ₦46.00 and ₦50.00 per sack.

Grade III: Consists of 'banda' made from inferior quality fish and heads, tails and bones of large fish. Grade III costs between ₦40.00 and ₦46.00 per sack.

Coiled 'banda' of *Clarias* spp. is also sold. It is smoke dried and packed in cartons (average weight 51.7 kg) and these are sold for between ₦40.00 and ₦50.00.

### *'Salanga'*

This product is prepared from *Alestes dentex* and *Alestes baremose* by allowing the fish to sun dry for a few days after they have been eviscerated and split open (Stauch and Alala, 1974).

## Packaging

Processed fish are packed in rather fragile cartons of two or three different sizes. The biggest cartons are used to convey smoke dried *Clarias* spp.; 'banda' is transported in sacks while 'salanga' is packed in mat containers. All these containers and contents are heaped up in the lorry; as a result the quality of the fish is badly affected by the time they reach the parts of the country (south) where they are to be sold at higher prices.

## Infestation

None of the methods of fish processing presently practised in the area under review is particularly successful; all the products suffer from a high level of contamination and insect infestation. Along the Nigerian shores and on the islands, the lack of suitable materials, both for building and fueling simple smoking ovens, is the prime reason for the absence of this good convenient fish processing method.

Hayward (1961) indicated that insect infestation is of two types: initially, when the moisture content of the flesh is high, it provides a suitable breeding ground for several species of flies (Calliphoridae and Muscidae); when the moisture content falls, the flies are replaced by dermestid beetles, typically *Dermestes maculatus* and *Necrobia rufipes.*

Accurate estimes of the wastage of 'banda' or other fish products after preparation have not been made in Nigeria. However, Stauch and Blache (1957) indicate that 'banda', transported over long distances in Cameroon and Chad, can incur losses of 20 to 75% of the initial dry weight due to insect infestation and mechanical damge during transport. Observations in Nigeria give a rough estimate of up to 40% of the original dry weight of protein being lost.

## Discussion

The Nigerian consumers have not discriminated between good and bad quality fish. Since the geographical situation of Lake Chad is in the semi-desert regions of the countries that surround it, firewood is scarce for smoking fish. Sun drying has been the more successful method of processing. However, salt, which could have been added to the fish before sun drying to speed up dehydration (salted sun dried fish), is scarce and costly. Arrangements could, therefore, be made by the authorities to supply salt and firewood at subsidized prices to the fishermen to enable them to improve fish processing. The ice making complex at Baga should be made operational and productive quickly to provide ice to the fishermen for preservation of their catches immediately after capture.

## Conclusion

Research into methods of improving fish handling and processing is greatly needed. Later, quality control in fish handling, processing, packaging and marketing may be implemented. It can be said that the catches increase when the water level of the lake falls compared to flood levels. From data published by ORSTOM (N'Djamena), we could speculate that the amount of water in the lake will soon increase and, when the level falls again, more fish will be caught.

Prices have risen tremendously due to economic development in the country and the high buying power of the consumers. Following the recent government initiated and decreed 'Operation Feed the Nation', combined with the operations of the Lake Chad Fisheries Development Project and the Lake Chad Research Institute, the fisheries industry will produce not only more fish but also better quality processed fish.

## References

**Hayward, L. A. W.** (1961) *Observations on the quality and losses of dried fish from Lake Chad.* (Mimeographed) Lagos: Federal Ministry of Commerce and Industry.

**Stauch, A. & Blache, J.** (1957) Preparation et commercialisation du produit de la pêche dans le bassin Lagone Chari-Lac TChad.

**Stauch, A. & Alala, O.** (Nov. 1974) Evolution of the Fisheries in the Lake Chad Basin area during the last five years.

**Tobor, J. C.** (1972) Some aspects of the fishing industry in the Nigerian north western sector of Lake Chad.

# The mycoflora associated with dry salted tropical fish

**Sarah Phillips and Ann Wallbridge**
Tropical Products Institute, UK

## Summary

Samples of tropical fish, dried, dried and salted, split dried, salted and smoked, were examined to determine the mycoflora associated with the fish after processing. The fungi isolated were *Aspergillus amstelodami* (Mangin) Thom and Church, *Aspergillus ruber* (Konig, Spieckermann, and Bremer) Thom and Church, *Aspergillus flavus* Link, *Aspergillus niger* van Tieghem, *Aspergillus chevalieri* (Mangin) Thom and Church, *Aspergillus ochraceus* Wilhelm, *Wallemia sebi* (Fr.) v. Arx, *Penicillium* spp., *Acremonium* sp. and *Rhizopus* sp.

The *in vitro* sensitivity to propionic acid and sorbic acid of *A. chevalieri, A. amstelodami, A. ochraceus* and *A. niger* was determined. Results showed that the fungi were sensitive to both inhibitors.

## Résumé

Des échantillons de poisson tropical, séché, séché et salé, fendu et séché, salé et fumé, sont examinés afin de déterminer la mycoflore associée au poisson après le traitement. Les champignons isolés sont *Aspergillus amstelodami* (Mangin) Thom et Church, *Aspergillus ruber* (Konig, Spieckermann, et Bremer) Thom et Church, *Aspergillus flavus* Link, *Aspergillus niger* van Tieghem, *Aspergillus chevalieri* (Mangin) Thom et Church, *Aspergillus ochraceus* Wilhelm, *Wallemia sebi* (Fr.) v. Arx, *Penicillium* spp., *Acremonium* sp. et *Rhizopus* sp.

La sensibilité *in vitro* à l'acide propionique et à l'acide sorbique de *A. chevalieri*, de *A. amstelodami*, de *A. ochraceus* et de *A. niger* est déterminée. Les résultats montrent que les champignons sont sensibles à ces deux inhibiteurs.

## Resumen

Se examinaron muestras de pescado tropical, seco, seco y salado, seco abierto, salado y ahumado, para determinar la micloflora asociada con el pescado después de su elaboración. Los hongos aislados eran *Aspergillus amstelodami* (Mangin) Thom y Church, *Aspergillus ruber* (Konig, Spieckermann, y Bremer) Thom y Church, *Aspergillus flavus* Link, *Aspergillus niger* van Tieghem, *Aspergillus chevalieri* (Mangin) Thom y Church, *Aspergillus ochraceus* Wilhelm, *Wallemia sebi* (Fr.) v. Arx, *Penicillium* spp., *Acremonium* sp. y *Rhizopus* sp.

Se determinó la sensibilidad *in vitro* al ácido propiónico y al ácido sórbico de *A. chevalieri, A. amstelodami, A. ochraceus* y *A. niger.* Los resultados mostraron que los hongos eran sensibles a ambos inhibidores.

## Introduction

Fish constitute a major source of protein in the diet of people in many developing countries, particularly those of SE Asia. Since processes such as canning and freezing are relatively expensive in these countries, salting and drying are among the most common and cheapest methods of fish preservation. The wide variation associated with these methods may depend on many factors including the size of fish, quality and price of salt, and local tradition and demand. Additionally, fish may be consumed locally, sold in markets or exported (eg from Thailand to Indonesia) which creates storage problems. In the hot, damp tropical climate, dry salted fish are highly susceptible to spoilage by micro-organisms, which flourish under these conditions; this considerably reduces the storage life (Van Veen, 1965).

The moisture content of smoked, salted or dehydrated fish may be such that mould development, rather than bacterial growth, takes place (Boyd and Tarr, 1955). Spoilage of dried fish was characterized by Sen and Lahiry (1964) as commonly consisting of a reddening, browning or other discolouration, mould attack and the development of rancidity or off-flavour. The authors studied the storage of sun dried mackerel, which could not be kept for more than two months in local Indian markets; through the development of a curing mixture and potassium sorbate dip before drying, the storage life was extended to six or seven months.

In this study, the mycofloras of dry salted fish from a number of countries were investigated to ascertain the potential problems connected with moulding of these products; the eventual aim was to improve and perhaps standardize the existing preservation methods.

## Materials and methods

### *Description of Samples*

A list of samples, their place of origin and method of processing is given in Table 1. Many samples were covered by a white encrustation thought to be due to salt since no hyphae or spores were observed on microscopic examination. Sample 1 seemed moist and sample 6 was visibly mouldy with green sporulating areas of mycelium covering most of the surface. No evidence of fungal growth was observed on samples 12 to 15 although mould development, in the form of greenish yellow colonies unevenly distributed over the inner and outer surfaces of the split fish, was apparent on samples 16 and 17.

### *Isolation of fungi*

Fungi were isolated by aseptically cutting portions of tissue (approximately 3 to 4 mm$^2$), both from unaffected and visibly mouldy areas of the surface, and placing these on plates containing media selective for xerophilic or halophilic species. Small whole fish were used for samples 12 to 15. The plates were incubated at 30°C. The details and water activity (Aw) of each medium are given in Table 2.

## Results

The fungi isolated from the fish samples are given in Table 3. Potato dextrose agar plates were covered by several fungi but the medium proved to be non-selective. Selection for xerophilic or halophilic species was achieved using malt extract agar plus 10, 15 or 20% sodium chloride.

TABLE 1. *Fish samples: origin and method of processing*

| *Sample no.* | *Species* | *Origin* | *Processing method* |
|---|---|---|---|
| 1 | Queenfish | Pakistan | Dried and salted |
| 2 | Anchovy | Thailand | Dried and salted |
| 3 | Lizardfish | Thailand | Dried and salted |
| 4 | Squid | Thailand | Dried |
| 5 | Squid | Thailand | Dried and salted |
| 6 | 'Sweet and seasoned' | Thailand | Dried and salted |
| 7 | Sepat | Thailand | Dried and salted |
| 8 | Ikan bawal putih | Malaysia | Dried and salted |
| 9 | Ikan bawal hitam | Malaysia | Dried and salted |
| 10 | Ikan sisa nabi | Malaysia | Dried and salted |
| 11 | Ikan sepat | Malaysia | Dried and salted |
| 12 | *Stolephorus buccaneeri* | Hong Kong | Dried and salted |
| 13 | *Stolephorus buccaneeri* | Hong Kong | Dried |
| 14 | *Etrumeus micropus* | Hong Kong | Dried and salted |
| 15 | *Stolephorus macrops* | Hong Kong | Dried |
| 16 | *Hydrocynus vittatus* | Zambia | Split dried, salted and smoked |
| 17 | *Mormyrops deliciosus* | Zambia | Split dried, salted and smoked |

TABLE 2. *Media used for isolation of fungi*

| *Medium* | *Samples* | *Water activity* |
|---|---|---|
| Potato dextrose agar to 250 ppm chloramphenicol (antibacterial) | 1 to 15 | 0.99 |
| Malt extract agar + 10% NaCl | 1 to 15 | 0.97 |
| Malt extract agar + 15% NaCl | 12 to 17 | 0.96 |
| Malt extract agar + 20% NaCl | 16 and 17 | 0.94 |

TABLE 3. *Fungal species isolated from fish*

| Sample no. | Fungal species | Species Unidentified |
|---|---|---|
| 1 | *Aspergillus amstelodami* (Mangin) Thom and Church | |
| 2 | *Aspergillus ruber* (Konig, Spieckermann and Bremer) Thom and Church | *Penicillium* sp. |
| 3 | *Aspergillus flavus* Link, *A. ruber*, *Aspergillus niger* van Tieghem | |
| 4 | *A. amstelodami* | |
| 5 | | *Penicillium* sp.<br>*Acremonium* sp. |
| 6 | *Wallemia sebi* (Fr.) v. Arx | *Penicillium* sp.<br>*Rhizopus* sp. |
| 7 | No fungi isolated | |
| 8 | *A. niger*, *Aspergillus chevalieri* (Mangin) Thom and Church | *Rhizopus* sp. |
| 9 | *A. niger, A ruber* | |
| 10 | No fungi isolated | |
| 11 | *A. chevalieri* | *Acremonium* sp. |
| 12 | *A. amstelodami* | *Penicillium* sp. |
| 13 | *A. amstelodami* | |
| 14 | *A. amstelodami* | *Penicillium* sp. |
| 15 | *A. amstelodami* | *Acremonium* sp. |
| 16 | *Aspergillus ochraceus* Wilhelm | *Acremonium* sp. |
| 17 | *A. ochraceus* | |

## Discussion

Storage fungi, mainly Aspergilli and Penicillia, were isolated from 15 of the 17 fish samples, regardless of the species or the processing method used. Aspergilli of the *Aspergillus glaucus* group were those most frequently isolated; these included *A. amstelodami, A. chevalieri* and *A. ruber*. These fungi and *W. sebi* were identified using a medium which provided a relatively low Aw, Czapek Dox agar with 20 or 40% w/w sucrose (Raper and Fennel, 1965).

Species within the *A. glaucus* group are characteristically xerophilic (Scott, 1957) although *A. ochraceus*, which can also withstand fairly dry conditions, was isolated from samples 16 and 17. In determining the influence of humidity on spore germination for various fungi, Snow (1949) showed that, for *A. amstelodami, Aspergillus repens* and *A. chevalieri*, the minimum level at which spores germinated was 75 to 73% relative humidity (RH) and as low as 70% RH for *A. ruber*. Our results compare with those obtained by other authors. Kikkiwa and Kosugi (1937) isolated *A. repens and A. ruber* from dried fish (bonito) which were actively being broken down by these species. Xerophilic fungi, including *A. glaucus*, three species of the *A. ochraceus* group, *Aspergillus candidus* and *Aspergillus versicolor*, were among those found on dried fish by Kita (1914). A xerophilic mould, *W. sebi*, was isolated from sample 6. *Sporendonema epizoum*, a synonym for *W. sebi*, has been reported as causing the 'dun' mould of salt fish and is tolerant of salt concentrations up to 26%.

The ability of xerophilic fungi to withstand conditions of low humidity means that they are frequently the primary colonizers of dried products. Once they are established and growing, an associated rise in the moisture content of the product allows less xerophilic fungi to develop. Many moulds require higher moisture conditions for spore germination and growth; among these, several (such as *Penicillium* sp., *Rhizopus* sp., *A. niger* and *A. flavus*) were isolated from the fish samples. Most penicillia and several aspergilli will grow at humidities above the critical limit of 86 to 80% RH whereas *Rhizopus nigricans* will germinate only at RH values higher than 90% (Snow, 1949).

Using a general nutrient medium, Okafor (1968) obtained two *Penicillium* species (71%), aspergilli (17%) (of which two species belonged to the *A. glaucus* and *A. ochraceus* groups) and *Scopulariopsis* (12%) from dried fish.

Food spoilage occurs rapidly at an Aw of 0.80 to 0.85. Fewer fungal species are capable of germination below this level and mould growth may be retarded (Scott, 1957). Storage studies, on dry salted catfish and mackerel (Suryanarayana Rao *et al.*, 1962), revealed that mould growth was a major cause of spoilage at all levels above 70% RH, where the equilibrium moisture content for these fish was 25%. Drying these products to a moisture content sufficient to inhibit the growth of xerophilic moulds may not be feasible for commercial storage (Frank and Hess, 1941) and may be unacceptable to consumers (Sen and Lahiry, 1962).

As a preliminary investigation into the control of mould growth by the addition of fungistats, four of the fungi isolated from the dry salted fish were screened *in vitro*. The minimum inhibitory concentration (M.I.C.) was determined for each fungus using propionic acid and sorbic acid as inhibitors. A sorbic acid concentration of 0.02% inhibited the growth of *A. chevalieri* and 0.04% was required to prevent the growth of *A. amstelodami*, *A. ochraceus* and *A. niger*. Propionic acid inhibited the growth of *A. niger* at a concentration of 0.05% and the other three Aspergilli at 0.1%.

*In vivo* experiments carried out by Boyd and Tarr (1954), incorporating sorbic acid into the brining process of salted fish, showed that a concentration of 0.05 to 0.1% inhibited the development of moulds and yeasts, including the development of the 'dun' mould. In the experiments by Frank and Hess (1941), propionic acid was effective in inhibiting 'dun' at a level of 0.3% within the pH range of 3.5 to 5.0.

In this present study, the fungi isolated provide an indication of the species most likely to cause spoilage of processed tropical fish during storage. Further studies may well lead to more standardized methods of preservation, resulting in higher quality products of better keeping capacity under tropical conditions.

## References

**Boyd, J. W. & Tarr, H. L. A.** (1955). Inhibition of mould and yeast development in fish products. *Food Technol.*, 9, 411–412.

**Frank, M. & Hess, E.** (1941). Studies of salt fish V. Studies on *Sporendonema epizoum* from 'dun' salt fish. *J. Fish. Res. Board Can.*, 5 (3), 276–278.

**Kikkiwa, F. & Kosugi, K.** (1937). The fungi grown on dried bonito (Abstr.) *Zentralbl. Bakteriol.*, II (97), 335.

**Kita, G.** (1914) Einige japanische Schmmelpilze. *Zentralbl. Bakteriol.*, II (41), 351–363.

**Okafor, N.** (1968) Fungi associated with mouldy dried fish. *Niger. J. Sci.*, 2 (1), 41–44.

**Raper, K. B. & Fennel, D. I.** (1965) The genus *Aspergillus.* Williams and Wilkins, 686 pp.

**Scott, W. J.** (1957) Water relations of food spoilage microorganism *Adv. Food. Res.*, 7, 83–127.

**Sen, D. P. & Lahiry, N. L.** (1964) Studies on the production of better quality salt-cured and sun-dried mackerel (*Rastrelliger kanagurta*). *Food Technol.*, 18, 107–110.

**Snow, D.** (1949) The germination of mould spores at controlled humidities. *Ann. Appl. Biol.*, 36, 1–13.

**Suryanaraya Rao, S. V., Valsan, A. P., Kandoran, M. K. & Nair M. R.** (1962) Storage behaviour of salted and dried fish in relation to humidity conditions. *Indian J. Fish.*, IX (2), 156–161.

**Van Veen, A. G.** (1965) Fermented and dried seafood products in Southeast Asia. In: *Fish as food* (ed. G. Borgstrom) *Vol. III: Processing*: Part I, pp. 227–250. New York: Academic Press, 489 pp.

# Discussion

For this session also there were two discussion periods, one after the presentation papers and one after the moderators review.

## Papers 1 and 2

In this period, discussion largely revolved around specific points made in the individual papers; only one individual topic resulted in a lengthy discussion, this was the question of labelling for sardines and sardine-like products.

The discussion was opened by **C. E. P. Watson** who felt that the first paper was over pessimistic, particularly in terms of the difficulties encountered in the development of small-scale fisheries, and failed to give much hope that improvements can be achieved through experience. He felt that the picture painted by **James** was more applicable to the situation of, say, 20 years ago. Achievements of the past few years such as the introduction of GRP canoes, improved landing places, auction halls and markets, and fishermen's co-operatives all represent 'development'. **James** replied that if one looks at a large number of poor rural situations in developing countries there has, in his opinion, been very little change over the years.

Whilst agreeing with **James** that there are many difficulties facing the artisanal fisherman, **Enin** hoped that Ghana's efforts in this direction may serve as an encouraging example. The numbers of small-scale fishermen had, she said, been declining mainly due to diminishing returns. Then, in 1972, there was a bumper harvest but the majority of the catch had to be thrown back into the sea because the market was saturated and processing facilities were also inadequate. The Government embarked on a programme (through the State Fishing Corporation) to increase the freezing facilities at Tema and to build new, or increase existing, cold stores throughout the country. Now, all surplus fish are purchased by the State, then frozen and stored for sale during the lean season; also, fishermen receive a guaranteed minimum price for their fish. It is hoped that these efforts will encourage existing fishermen and perhaps even attract more.

Discussion continued with further comments on the paper by **James**. **Golley-Morgan** noted the lack of ability of many artisanal fishermen to obtain any financial assistance for development and commented on the possible competition between the artisanal and industrial fishery for financial resources.

**Dhatemwa** questioned the statement expressed in the **James** paper that all fish of any quality is consumed and that the cost of producing high quality is not justified. In many countries consumers are used to eating only that which has been presented to them; experience in Uganda has shown that consumers quickly appreciate the better quality brought about through improved handling and processing practices and are willing to pay more for quality fish.

Development of small-scale fisheries within the co-operative set-up was considered by **Cayetano-Reyes** to be very difficult; he felt that the middleman system is preferable for artisanal fishermen.

**Faubeau**, suggesting that nuoc-mam production represented an enormous benefit to the fishermen of Vietnam, felt that it could be produced by artisanal fishermen in other countries confronted by the problems outlined by **James**.

At the Chairman's suggestion a new topic was opened for discussion by **Sabri**. Referring to the **Balachandran** and **Nair** paper, he queried the rationale of subsidizing the export of canned sardines and asked why the figure of 20% was used for the subsidy. **Kuriyan**, replying on behalf of the authors, explained that India needs foreign exchange; one way of securing this is to export canned sardines and the subsidy has greately boosted exports. The maximum subsidy which the Government will give is 20%. **Sagua** commended this example and felt it to be worthy of emulation by other developing countries with export-orientated fishing industries. This view was supported by **Enin**.

A lively discussion on labelling of canned 'Sardines' then followed. **P. K. Watson** noted that, in the Indian paper, emphasis has been placed on the canning of 'Sardines' but the European market may accept such species (*Sardinella longiceps*) only under the 'Sardinella' label. **Moal** commented that Codex Alimentarius have allowed species other than true sardines under the 'Sardine' label. He felt, however, that a new low-cost market could be found for *Sardinella*. The naming of canned sardine and sardine-type products has, remarked **Lima dos Santos**, been under discussion by the Codex Committee of Fish and Fishery Products at Bergen for many years; the feelings of the Committee are that the characteristics of the end product should determine the labelling rather than the actual species used. Many of the large producers of canned sardine products, eg Brazil, Mexico and Venezuala, use different species of small clupeid fish; the product is, he said, very similar in quality and type to that made from traditionally used *Sardina pilchardus* and is sold as 'Sardine' on the international market. **Watkin** then stressed that in the UK the law allows only *Sardina pilchardus* to be canned as 'Sardine'. This law, which seeks to prevent incorrect labelling of goods, comes under the Consumer Protection Administration. The fine for the first offence is £100, rising to £400. **Lima dos Santos** and **Mattos** commented that labels should meet the customers requirements and be in accordance with the legislation of the individual importing countries; labelling is essentially a marketing problem.

### Papers reviewed by the moderator

In this session, most authors spoke on their papers and the discussion primarily considered the use of insecticides and other methods to control insect infestation. The need to conserve wood in fish smoking is also clearly an important topic. The only new information not appearing in the printed papers was from **Proctor** who outlined the encouraging findings of the recent trials carried out in Mali using Gardona.

**Azeza** opened the discussion pointing out that pyrethrum is considered safe for use but only if the processors know how much to use. Both **Talabi** and the Chairman emphasized the need for training in the correct use of insecticides. **Proctor** then added that traders, when shown, quickly learnt how to use the insecticide. **Watson**, however, stressed that it can be dangerous to allow indiscriminate use of insecticides by individual fishermen; he felt they should, preferably, be used at central depots where control can be exercised.

Examples of other methods of controlling insects were then given. **Kuriyan** told the meeting that in India they use a low concentration of sodium propionate rubbed into the fish; this not only gave the product a long shelf life but also protected it against insects for nine months. In Israel, insect control in fish processing plants is, said **Herzberg**, effected mainly through good sanitation. Dustbins and other areas of possible insect propagation are sprayed but insecticides are never used on the products themselves. **Talabi** suggested that the use of salt, to control insect development, should continue while research is conducted into the use of other chemicals.

Comments from the floor on the question of good housekeeping versus insecticides were invited by **Disney**, who also asked **Rogers** to outline the work in Malawi on the development of simple cheap methods of treating small, whole fish. A low concentration of insecticide was applied using a liberal washing technique. In the initial stages, flies were repelled; as drying progressed the insecticide (pyrethrum) level increased, due to loss of moisture, and fly larvae were killed. At the end of the drying period, the concentration of insecticide should be sufficient to control *Dermestes* spp.; in these trials, however, the fish were marketed soon after drying and dermestids were not a problem.

Against insecticides, **Lima dos Santos** told of a disastrous experience in Brazil which resulted in a number of cases of food poisoning. Fishermen were advised to use the insecticide but were not told how to use it and the fish were salted with a mixture of salt and insecticide. Another delegate preferred 'good housekeeping' because it is difficult to make an acceptable product when the insecticide is applied directly to the fish. **Talabi**, however, felt that good housekeeping alone is not sufficient in certain circumstances such as the processing factories around Lake Chad where flies create a serious problem. In situations where there is a choice between good housekeeping or use of an insecticide, **Proctor** recommended good housekeeping. He pointed out that pyrethrum is well tested and is safe if used properly, but was concerned that there should be a single system for dilution such as 'use one tin and dilute into one bucket'. Finally, on this point, **Tyler** stressed that extensive trials should be carried out before adopting any insecticides since their performance depends on the type of fish, whether freshwater or marine, its size, oil content, etc.

Reference was then made by **Disney** to the work in Zambia on the use of brine. **Proctor** briefly mentioned that the salt taken up during brining suppresses larval development, not oviposition. **Sagua** also mentioned their work on salted sun dried fish. The salt protects against flies during drying and reduces dermestid activity. Although expensive, they have found that polythene packaging does protect the dried fish against dermestids. On dermestid activity, **Taylor-Thomas** added that, in The Gambia, if the fish are smoked periodically and if they are not stored for long periods, there is no dermestid attack.

The final points touched upon in this discussion followed **C. E. P. Watson's** comment (which was strongly endorsed by **Disney**) on the growing shortage of firewood in many developing countries and the need, therefore, to develop improved smoking methods in order to conserve fuel and upgrade the product. **Moal** and **Disney** mentioned that centralized processing would have certain advantages such as conserving fuel, quality sorting, etc but this is not always easy to arrange.

The efforts of the International Development and Research Centre and the Ghana Government project to improve rural fisheries were brought to the attention of the meeting by **Otitiaku.** As part of the project, a modified Altona type smoking oven is now used; elevated drying racks made from bamboo have also met with considerable success.

On the type of fuel which can be used, **Talabi** mentioned that a wood/charcoal combination reduces the smoke level and added that details on the relationship of thermal efficiency to water content in fuels, and on resin levels and flavour, have been published by the Russians. The Chairman noted that green wood cannot be used and **Taylor-Thomas** mentioned that they use tar-free wood for smoking; palm kernels are used for smoke and flavour production.

Finally, brief comment was made by **Peterkin** on the use of solar power for drying fish.

# Session 7

## Shellfish

**Thursday 8th July**
**Afternoon**

Chairman
G. K. Kuriyan
Central Institute of Fisheries
Technology,
India

Moderator
T. J. Billy
Department of Commerce
USA

Rapporteur
C. A. M. Lima dos Santos
Ministry of Agriculture
Brazil

# Historic and developmental problems in the Guianas and Caribbean shrimp fishing industry

**F. A. Peterkin**
Guyana Food Processors Ltd, Guyana

**Summary**

The paper outlines the historical background to the Guianan and Caribbean shrimp fishing industry and reviews its present status. Research and development projects geared towards a development of the industry are discussed. Particular reference is given to the development of new products from the indigenous species with a view to providing much needed protein in the Caribbean region.

The problems of quality control and marketing of shrimp are discussed and possible future developments outlined.

**Résumé**

L'article rappelle les notions historiques concernant le produit de la pêche à la crevette en Guyane et aux Caraibes et passe en revue son état actuel. Sont étudiés les projets et recherches concernant le développement industriel. Une attention particulière est portée au développement de nouveaux produits provenant des espèces indigènes dans le but de fournir une grande part des protéines dont a besoin la région des Caraibes.

Les problèmes de contrôle de qualité et de commercialisation de la crevette sont discutés et de possibles développements pour l'avenir sont esquissés.

**Resumen**

El artículo expone brevemente los antecedentes históricos de la industria pesquera de camarones de las Guayanas y el Caribe y hace una revisión de su estado actual.

Se analizan los proyectos de investigación y desarrollo para el desarrollo de la industria. Se hace especial referencia de la explotación de nuevos productos de especies indígenas con vistas a suministrar proteínas muy necesarias en la región del Caribe.

Se estudian los problemas del control de calidad y comercialización de las camarones y se perfila el posible desarrollo futuro.

## Introduction

The Caribbean and the Guianas, like other developing countries of the world, are looking to those natural resources within their jurisdiction to provide their people with a better way of life. In Guyana, for instance, the shrimp fishing industry has provided much needed hard currency to allow the Government to proceed with its developmental programmes.

Other aspects of the Guyanan industry have recently appeared, mainly as a result of 'The Feed, Clothe and House the Nation Programme'. This paper, therefore, will give a brief insight into this rather complex development.

## Brief history of the industry

The commercial shrimp fishery off the north-eastern coast of South America, as we know it today, began in 1959. The results of cruises by the US exploratory fishing vessel 'Oregon' in the autumn of 1957 and the late summer of 1958 focussed the attention of the US shrimp industry on the Guianas region (Bullis and Thompson, 1959). Other surveys also contributed to the knowledge of the shrimp and fish resources of the region (US Fish and Wildlife Service, 1954; Richards, 1955; Salmon, 1958; Higman, 1959; Durand, 1959; Mitchell and McConnell, 1959). As a result, commercial shrimping vessels began operating from Paramaribo in October

TABLE 1. *Number of trawlers fishing in the area*

| | *Guyana (Georgetown)* | *Surinam (Paramaribo)* | *French Guiana (St Laurent and Cayenne)* | *Brazil (Belem)* | *Trinidad* |
|---|---|---|---|---|---|
| 1964 | 101 | 25 | 51 | – | – |
| 1965 | 96 | 25 | 58 | – | – |
| 1966 | 105 | 34 | 67 | – | – |
| 1967 | 113 | 50 | 89 | – | – |
| 1968 | 143 | 55 | 90 | – | – |
| 1969 | 152 | 51 | 110 | – | 63 |
| 1970 | 175 | 75 | 89 | – | 92 |
| 1971 | 180 | 75 | 44 | 27 | 115 |
| 1972 | 185 | 80 | 69 | – | 67 |
| 1973 | 214 | 96 | 61 | 62 | 52 |
| 1974 | 245 | 150 | 69 | – | 50 |

TABLE 2. *Total landings (lb)*

| | *Guyana (Georgetown)* | *Surinam (Paramaribo)* | *French Guiana (St Laurent and Cayenne)* | *Brazil (Belem)* | *Trinidad* |
|---|---|---|---|---|---|
| 1964 | 7,055,000 | 1,322,938 | 2,961,163 | 34,500 | – |
| 1965 | 8,157,000 | 1,408,520 | 3,960,271 | 473,223 | 179,700 |
| 1966 | 9,480,000 | 2,080,371 | 4,668,248 | 486,485 | 1,227,650 |
| 1967 | 9,039,000 | 2,129,182 | 6,717,361 | 175,680 | 1,710,421 |
| 1968 | 9,259,000 | 3,211,524 | 7,820,264 | 1,619,495 | 3,075,585 |
| 1969 | 10,582,000 | 2,885,829 | 6,036,954 | 3,706,961 | 2,643,013 |
| 1970 | 11,877,253 | 2,582,432 | 5,053,537 | 2,605,478 | 3,895,109 |
| 1971 | 11,379,854 | 2,128,381 | 3,807,582 | 4,405,472 | 2,433,859 |
| 1972 | 11,575,700 | 2,132,556 | 3,621,681 | 8,931,359 | 1,311,416 |
| 1973 | 14,659,000 | 1,851,874 | 3,919,710 | 4,263,461 | 1,529,465 |
| 1974 | 12,333,000 | – | – | – | – |

Figures obtained from various sources and from Government ministries in the territories.

1958, from Georgetown in January 1959 and from other parts in early and mid- 1960. Landings are made at five ports: Georgetown, Paramaribo, St. Laurant, Cayenne and Belem. Vessels from a number of different countries (the United States, Japan, Korea, Cuba, Guyana, Trinidad, Tobago, Surinam and Brazil) are, at present, fishing in the area.

The industry off the coast of the Guianas grew rapidly from the very beginning. Table 1 shows the best available estimates of the number of boats, based in each country, which are fishing in the area. The figures are rather sketchy but they indicate the growth of the fleet over a ten year period. The present Guianas shrimp fleet is fairly modern and of uniform size of vessel, gear and power unit (Naidu and Boerema, 1972).

The first year for which reliable catch statistics are available is 1960 when total landings were 4 million pounds (Naidu and Boerema, 1972). Since then the catches, particularly in Guyana, have continued to increase (Table 2) with high production in 1970, 1971, 1972 and 1973. There was, however, a decline in 1974 and 1975.

The foregoing gives a brief outline of the historic background and growth of the industry. In recent years, however, there have been several surveys by both USA and Japanese exploratory fishing vessels, chiefly trying to determine the extent of the resource and the effects of year-round fishing. In 1974 and 1975, trips by the RV 'Oregon' were made to determine the composition and distribution of the commercial shrimp stock off the coast of the Guianas. In 1974, the Japanese RV 'Kaiyo Maru' also carried out an extensive exercise on evaluating the resource, establishing catch patterns and investigating the biology of the species.

## Resource and its development

Three species of penaeid shrimp (*Penaeus brasiliensis, Penaeus aztecas subtilis* and *Penaeus duorarum notialis)* comprise the majority of commercial landings; they are processed mainly as pink shrimp. In recent years, chiefly for the Japanese trade, emphasis has also been placed on the indentification and packing of white shrimp (*Penaeus schimitti*). All the shrimp are processed 'head-off' and packed in consumer packs of 5lb and 2kg. Also present in the area in commercial quantities (particularly inshore) is the sea-bob (*Xyphopeneus kroyeri*). At present, this species is harvested only in St Laurent and Cayenne and is mainly exported to Europe.

Because the highly priced shrimp have been the prime objective of the industry, little or no notice has been given to the more prolific resource, namely fish. However, the emphasis now is to find a cheap and readily available source of protein in the region and it is becoming increasingly evident that the harvesting of fish must assume a greater importance in the industry.

The shrimp industry has, in the past, played a significant role in developing the economy of the region, particularly in earning hard currency, in providing employment and in capital investment. Statistics show that, of all the territories in the region, Guyana has possibly been the most stable. In 1975, however, the industry suffered a set-back due to two factors: high fuel costs and low production of shrimp.

Efforts are being made to overcome both of these set-backs, but it is understandable that this will need protracted investigation and effort. With reference to the low production of shrimp, considerable thought has been given to the possibility of overfishing, the use of unsuitable gear and indiscriminate dumping. No official conclusions have been reached but investigations have disclosed the need for a closer look at the controls and for possible legislation in the area.

I would like to return to my previous reference to fish, in particular the by-catch of the shrimping industry. A conservative estimate of the by-catch, based on the number of vessels, the catch rate and duration of operation, indicates that at least 200,000 tonnes of fish are dumped each year on the fishing grounds by the shrimp trawlers. It is obvious that the countries and territories in this area can ill-afford this wastage, particularly as most of them have control programmes for the importation of fish and fishery products. Consequently, great emphasis is now being placed on this aspect of the industry and on the methods which can be adopted to collect, bring in and process this wasted resource.

Early in 1973, the International Development and Research Centre of Canada (IDRC) started a project in Guyana, based on the estimates of the by-catch of the shrimp industry, to develop means and processes to make use of the under-utilized species of the by-catch. This project has, in the initial stages, been concerned with the collection of data from the shrimp trawlers and with the development of techniques to make the lesser known and lesser eaten species into attractive, acceptable products for human consumption.

These investigations have so far disclosed the presence, in commercial quantities, of the following food fish: *Macrodon ancyloden* (banga-mary, whiting or small salmon); *Cynoscion virescens* (sea trout or salmon); *Micropogen furnuri* (croaker); and several species of catfish. In addition, there are small quantities of other edible fish and a large amount of marine life.

The RV 'Cape St Mary' survey showed a catch composition of 43% croakers, 19% banga-mary and 11% sea trout. The United Nations Development Programme (UNDP) survey found 44% sea trout, 15% mixed fish and 10% croakers. Various other surveys have shown different catch compositions but they all agree that large quantities of the above mentioned species (particularly croakers) are present. Current surveys by the Ministry of Agriculture in Guyana indicate the presence of large quantities of banga-mary at some period of the year on the penaeid shrimping grounds. These surveys also revealed inshore resources of sea-bobs rivalling the concentration of commercial penaeids. All of the species mentioned will, hopefully, be used to produce high grade fishery products for the region.

The research presently being carried out will seek to develop products capable of meeting the traditional tastes of the various territories as well as to satisfy the nutritional needs of the region. The following products have been developed: fresh frozen fish in the round, fresh frozen fillets, fresh frozen fish steaks, dry salted fish, pickled fish, smoked fish, and fresh frozen shrimp (head-off). Dry salted shrimp and marinated fish products are in an advanced stage of development. A number of other products are in the early stages of development: breaded fish products, comminuted fish products (fish sausages, kamaboko), frozen pre-cooked sea-bobs, canned small fish, and fish meal. Preliminary experiments with the latter group have shown that all these products could be prepared from the species prevalent in the area.

In the immediate future, however, emphasis will be placed on the first seven fully developed items, which will meet the traditional tastes of the region and will assist in maintaining a stable cost of living index. Production will start at a Project Development Centre in Guyana early in 1976. The vast untapped resource of sea-bobs should be the basis for the development of dry salted shrimp, canned small shrimp and frozen pre-cooked small shrimp.

It is now fully recognized that there are substantial fishery resources off Guyana and the Guianas. These resources are still under-utilized, owing to a number of constraints mentioned in this paper. Efforts are being made to surmount these difficulties and, with good management, inter-regional trade and nutritional benefits will accrue to the credit of the region.

## Quality control and marketing problems (Guyana)

The shrimping industry has, over the years, had its own peculiar problems. In the old days and up to the late sixties when the majority of the boats were wooden and not refrigerated, there was the year-round problem of slimy shrimp and shrimp with black spot. These problems, caused by bad icing, dirty fish holds and poor handling by the crew, have mostly disappeared with the advent of the refrigerated fish hold. As a result, a much higher quality of shrimp is landed and there has been a greater need for better onshore quality supervision, better packaging and more sophisticated storage facilities. It is no wonder, therefore, that the industry is reluctant to endanger its prime product by harvesting and storing the by-catch. Consequently, efforts are therefore being made and studies carried out to find the best possible means of landing the by-catch.

The greatest marketing problem in the region is the absence of refrigerated carriers. The Caricom countries have been almost completely without adequate supplies of seafoods due to this single factor. Recently, discussions have been conducted to find ways and means to remedy this situation. When a solution is found, it is planned to develop the harvesting of sea-bobs (X. *kroyeri*) for export to the Caricom area, thus maintaining our lucrative international markets for pink and white shrimp, and also satisfying the nutritional needs of this region.

The most recent Caricom Food Plant will accelerate action in this respect and will be particularly beneficial when the anticipated delays in the dairy and beef production programme for the region are considered.

## Expansion and prospects of the industry

Shrimp sales will continue to be a valuable hard currency earner in the shrimping countries of the Caribbean. In the case of Guyana, some diversification and the development of processing the by-catch from the shrimp trawlers could result in a significant development in the industry.

Guyana has one of the largest shrimp plants in the world, capable of handling 64,000 pounds of shrimp per day and with a storage capacity of 2.5 million pounds. This plant was designed to serve the 75 to 100 foot trawlers and cost over G$9.0 million.* Also in the course of planning and construction in Guyana is the Demerara Fish Port, comprising docking and servicing facilities for over 200 boats and a fish plant capable of handling 40 million lb of raw fish per year.

In order to facilitate this degree of expansion, the help of IDRC and other agencies is necessary. Also, several research and training programmes have been instituted and are in progress, for example, at the UNDP Fisheries Training Institute in Trinidad, the fishermen of the region are being trained in navigation and seamanship. Some are also being sent to Canada and Japan to be trained in fish processing, microbiology and food technology. Serious discussions are in progress with respect to the establishment of a Fisheries Development Authority in Guyana. In addition (and in keeping with the needs of the area), product development and research are being carried out to make available seafood products which have become almost unobtainable due to the restrictions on hard currency imports. The by-catch of the shrimping industry will play a significant role in the availability of these products in the near future.

The solution to the harvesting problem may be to use collector vessels or motherships to relieve the limited space on the shrimp trawlers and to feed the onshore facility. The availability of refrigerated carriers in the territories as well as refrigerated inter-territorial ships must also form a major part of the expansion programme. The programme, aimed at providing the young nations of the Caribbean with cheap protein products, is of the most vital importance if the islands and territories are to maintain a healthy nutrition programme as well as stabilizing and containing the cost of living.

## Conclusions

It has been necessary, due to the scope of this paper, to omit detailed quotations of figures and statistics. However, the writer has tried to give a 'thumb nail' picture of the industry. I am sure you will now realize that in the early days of the industry the prime motive was to derive much needed hard currency to secure machinery and consumer goods from the developed countries. However, this emphasis has changed considerably and we are now looking to the industry to provide a cheap and readily available means of protein for the young nations of the Caribbean.

In terms of the World Food Programme, the shrimp fisheries of the Guianas have a very significant role to play and the Governments in the area have shown the type of foresight and initiative which could well benefit the whole of the Caricom region. When all of the crises in the world are looked at very carefully, we must recognize that the biggest crisis of the future will be the need for more food.

## References

**Bullis, H. R. Jr. & Thompson J. R.** (1959) Shrimp exploration by the MV Oregon along the northeast coast of South America. *Commer. Fish. Rev.*, **21** (11), 1–19.

**Durand, J.** (1959) Les elements principaux de la faune et leurs relations avec le fond. *Cahiers de l'ORSTOM* No. 3, 93pp.

**Higman, J. P.** (1959) Surinam fishery explorations. May 11–July 31, 1957. *Commer. Fish. Rev.*, **21** (9), 8–15.

**Mitchell, W. G. & McConnell, R. H.** (1959) The trawl survey carried out by RV Cape St Mary off British Guiana 1957–59. Part 1: Summary of the survey, and Part 2: The interpretation of the catch records. *Br. Guiana Fish. Div. Georgetown, Bull.* No. 2, 1–53.

**Naidu, K. S. & Boerema, L.** (1972) The high-sea shrimp resources off the Guyanas and northern Brazil. *FAO Fish. Circ.*, No. 141, 18pp.

**Richards, A. R.** (1955) *Trawlfishing in the South-Eastern Caribbean.* A report prepared for the Government of Trinidad and Tobago and the Caribbean Commission. Port-of-Spain, Trinidad: Caribbean Commission, 147pp.

**Salmon, G. C.** (1958) Report on the fisheries industry in the countries served by the Caribbean Commission. (Translation). Central Secretariat, Caribb. Comm. Port-of-Spain, Trinidad, Rep. No. 781.

**US Fish and Wildlife Service** (1954) Good shrimp fishing possibilities reported. *Commer. Fish. Rev.*, **16** (2), 53.

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*1 Guyanese Dollar (G$) = £0.23 as at June 1976.

# Export of shrimp from India

**B. L. Amla and D. P. Sen**
Central Food Technological Research Institute, India

## Summary

During the last decade, the pattern of seafood exports from India has changed dramatically, mainly in relation to the increase in shrimp exports. The extent of this change is considered here.

Shrimp fishing takes place largely in coastal areas but recent attempts have been made to harvest shrimp from deeper waters.

To ensure 'proper' quality for shrimp products, statutory bacteriological standards and pre-shipment inspection procedures have been introduced. The Marine Products Export Development Authority, a government agency, has specified statutory technical standards for fishing vessels, pre-processing centres, processing plants, packing centres, storage premises and conveyances.

The Indian shrimp industry can hold its ground against competition from other countries; the need for modernization of the industry, to continue expansion, is outlined.

## Résumé

Au cours des dix dernières années, la conception que l'on avait des exportations des produits de la mer provenant de l'Inde s'est complètement modifiée, en particulier en ce qui concerne l'augmentation des exportations de crevettes. L'importance de ce changement est étudiée dans cet article.

La pêche à la crevette occupe une place importante dans les zones côtières, mais de récentes tentatives ont été faites pour pêcher la crevette dans des eaux plus profondes.

Pour assurer une qualité convenable à la crevette, des normes bactériologiques réglementaires et des mesures d'inspection avant la pêche ont été introduites. L'Autorité responsable du Développement pour l'Exportation des Produits de la Mer, organisme gouvernemental, a spécifié les normes techniques réglementaires pour les bateaux de pêche, les centres de pré-préparation, les usines de préparation, les centres d'emballage, les établissements de stockage et les moyens de transport.

L'industrie Indienne de la crevette peut rivaliser avec celle des autres pays; le besoin de modernisation de l'industrie pour une poursuite de l'expansion est souligné.

## Resumen

Las exportaciones de mariscos de la India han experimentado un cambio muy importante durante la última década, principalmente por lo que se refiere al aumento en las exportaciones de camarones. En el artículo se analiza el alcance de este cambio.

La pesca de camarones tiene lugar principalmente en las zonas costeras, pero se han hecho intentos recientes para que sea en aguas más profundas.

Para asegurar la calidad adecuada de los productos se han introducido normas bacteriológicas estatutarias y procedimientos de inspección para antes del embarque. El Departamento para el Desarrollo de la Exportación de Productos Marinos, que es una agencia del gobierno, ha especifado estatutariamente normas técnicas para los barcos de pesca, centros para el pre-elaborado, plantas de elaboración, centros de embalje, locales de almacenamiento y transporte. La industria India de camarones puede mantenerse firme frente a la competencia de otros países; se explica en términos generales la necesidad de modernización de la industria, para que pueda continuar su expansión.

## Introduction

Shrimp constitute an important fishery in India. Approximately 10% of the total marine fish catch, 1.13 million tonnes in 1974, is shrimp. In earlier years, the surplus catch of fish, shrimp, prawns etc was almost exclusively dried, salted or pickled. In 1951, for the first time in India, a small plant, with the capacity to freeze 1.5 tonnes of shrimp per day and to store 50 tonnes of the frozen product, was set up. In 1953, a small consignment of 29,000 lb of frozen shrimp was exported to the USA. From this humble beginning, Indian shrimp quality was soon appreciated and exports increased rapidly. In 1959, canned prawns also became an important export commodity. Today (1975), Rs 1,050 million* of Indian seafoods is exported and this is mainly frozen and canned shrimp.

## Export profiles

Until the early 1960's, the traditional marine products such as dried, dry salted and wet salted fish, fish manures, fish guano, fish maws, shark fins, fish meal and oil) were the bulk of the export while frozen products occupied only a minor postion. However, the export of frozen products gathered momentum by the end of the 1960's and the export of canned products at that time was moninal. To illustrate this, in 1960 traditional products accounted for 87.4% of the quantity (74.8% of the value) of the total exports. Corresponding figures for frozen products (all shrimp) were 10.0% and 19.3% respectively. In 1964, frozen and canned products occupied a predominant position and accounted for approximately 60% of the export value. By 1975, frozen shrimp accounted for 90.0% of the export value, frozen lobster tails for 1.5% and canned prawns for 0.6% (see Tables 1 and 2).

## Marketing trends

The change in the pattern of exports is closely linked with the change in marketing conditions. During 1950 to 1960, when traditional fish products formed the bulk of the exports, Sri Lanka had been the principal buyer

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*1 Indian Rupee (Rs) = £0.06, at June 1976

TABLE 1. *Export of marine products and frozen shrimps from India.*

| *Year* | *Marine products* | | *Frozen shrimps* | |
|---|---|---|---|---|
| | *Quantity (tonnes x $10^3$)* | *Value (Rs x $10^6$)* | *Quantity (tonnes x $10^3$)* | *Value (Rs x $10^6$)* |
| 1957 | 22.8 | 45.9 | 0.5 | 2.1 |
| 1958 | 30.7 | 58.7 | 0.8 | 3.8 |
| 1959 | 33.7 | 62.3 | 1.1 | 4.9 |
| 1960 | 16.3 | 40.2 | 1.2 | 5.9 |
| 1961 | 17.3 | 41.3 | 1.5 | 7.4 |
| 1962 | 11.6 | 37.5 | 2.2 | 10.8 |
| 1963 | 17.9 | 58.7 | 4.0 | 21.2 |
| 1964 | 21.5 | 68.5 | 5.9 | 31.5 |
| 1965 | 15.5 | 69.2 | 7.0 | 41.4 |
| 1966 | 19.2 | 135.2 | 8.8 | 88.8 |
| 1967 | 21.8 | 199.3 | 11.2 | 129.8 |
| 1968 | 24.8 | 220.9 | 14.4 | 156.3 |
| 1969 | 30.6 | 330.7 | 21.4 | 263.0 |
| 1970 | 37.2 | 355.4 | 22.1 | 242.5 |
| 1971 | 34.0 | 391.7 | 23.2 | 313.0 |
| 1972 | 38.3 | 581.3 | 30.6 | 509.0 |
| 1973 | 48.8 | 795.8 | 35.9 | 658.0 |
| 1974 | 46.6 | 763.1 | 34.4 | 637.3 |
| 1975 | 53.4 | 1,049.1 | 46.8 | 943.3 |

TABLE 2. *Marine products export (1975)*

| *Export product* | *Quantity* | | *Value* | |
|---|---|---|---|---|
| | *(tonnes)* | *(%)* | *(Rs x $10^3$)* | *(%)* |
| Frozen shrimp | 46,831 | 87.7 | 943,386 | 89.9 |
| Frozen lobster tails | 402 | 0.8 | 15,760 | 1.5 |
| Frozen frogs legs | 1,317 | 2.5 | 27,983 | 2.7 |
| Frozen fish | 134 | 0.3 | 1,884 | 0.2 |
| Frozen cuttlefish | 1,017 | 1.9 | 29,071 | 2.8 |
| Canned shrimp | 261 | 0.5 | 5,999 | 0.6 |
| Dried shrimp | 99 | 0.1 | 1,132 | 0.1 |
| Dried fish | 2,295 | 4.3 | 9,061 | 0.9 |
| Shark fins and fish maws | 307 | 0.6 | 9,822 | 0.9 |
| Others | 749 | 1.4 | 4,965 | 0.5 |
| *Total* | 53,412 | 100.00 | 1,049,063 | 100.00 |

taking more than two thirds of the total export. Burma and Singapore came next accounting for 20% on average. This position continued as long as exports were dominated by dried products. Today, seafood exports, consisting essentially of frozen and canned products, are mainly to countries such as the USA, Japan, Australia, the UK and European countries. The biggest buyers, Japan and the USA, account for 93% of the total amount of frozen shrimp exported from India. Australia is another principal importer.

Frozen shrimp are packed and shipped in four different physical profiles: 'headless shell-on'; 'peeled and de-veined'; 'peeled and not de-veined'; and 'cooked and peeled'. Each of these varieties caters for the demand of a particular market as shown below:

| | |
|---|---|
| Headless shell-on (all large shrimp) | Japan |
| Peeled and de-veined (all small shrimp) | USA |
| Cooked and peeled (all small shrimp) | Australia |
| Peeled and not de-veined | Japan |

The UK, the USA and Western Europe are the principal buyers of Indian canned shrimp. The canned shrimp sold to European buyers also finds its way to the USA market. Singapore and Hong Kong have been constant buyers of Indian dried shrimp but recently (1974 to 1975) the European and Japanese markets have imported more than these two countries.

## Shrimp resources

The shrimp fishery in India is divided into two main groups; penaeid and non-penaeid. Penaeid prawns are more important for the export market and the species which contribute to the catch are: *Penaeus indicus, Metapenaeus monoceros, Metapenaeus dobsoni, Metapenaeus affinis* and *Parapenaeopsis* spp.

The total prawn production in the world today is of the order of 0.7 x $10^6$ tonnes. India's contribution is approximately 0.2 x $10^6$ tonnes and she is the second major supplier of shrimp. Coastal penaeid prawns account for 0.11 x $10^6$ tonnes of the total crustacean catch of 0.18 x $10^6$ tonnes (1974) (Table 3). States, such as Kerala, Maharashtra and Karnataka, situated on the west coast of India, catch more than three quarters of the penaeid prawns. Of these states, Kerala is the most important since more than half of the total catch is landed there.

Export prospects gave a great impetus to the introduction of mechanized boats for fishing; in 1960, there were few of these but India now has a fleet of more than 10,000 boats. These are predominantly small boats (not more than 12 m) and they operate in inshore areas (10 to 15 km from the shore at 10 fathoms). With the introduction of mechanized boats, the penaeid prawn catch has gradually increased.

However, of late, it has been noted in Kerala (south west coastal region), where there is the maximum concentration of mechanized boats and fish processing units, that, due to overfishing, there is a limit to the availability of shrimp. To overcome this problem, measures have been suggested to augment the shrimp catch:

1. *Prawn culture in paddy fields.* The yield from the sea, by exploiting the natural population of prawns, is about 28 kg/hectare. In paddy fields, where prawn culture is undertaken for about 6 months a year, it is about 1500 kg/hectare. In Kerala alone, 16,000 hectares of water is ideally suited for prawn farming. In Japan, a yield of 6,000 kg/hectare has been reported.
2. *Fishing in deep waters.* To avoid overfishing in inshore areas and to augment the supply, fishing in deep waters is a necessity. A survey conducted by the Indo-Norwegian team along the south west and south east coasts has established fairly good crustacean resources (deep-sea prawns and lobsters). Programmes to introduce medium sized (approximately 18 m) mechanized boats, capable of trawling beyond 10 fathoms, have already been initiated.

## Improvement of processing techniques

Shrimp exports have given rise to the establishment of many modern freezing and canning units. There are

TABLE 3. *Total landings of marine fish and crustaceans in India from 1963 to 1974 (tonnes x $10^3$)*

| | | *Crustacean landings* | | | |
|---|---|---|---|---|---|
| *Year* | *Total landing* | *Penaeid prawns* | *Non-penaeid prawns* | *Other crustaceans* | *Total* |
| 1963 | 655.5 | 41.1 | 40.5 | 2.0 | 83.6 |
| 1964 | 859.6 | 63.4 | 31.5 | 4.6 | 99.5 |
| 1965 | 832.8 | 38.1 | 41.4 | 2.4 | 81.9 |
| 1966 | 890.3 | 56.2 | 34.8 | 3.7 | 94.7 |
| 1967 | 891.9 | 63.1 | 31.1 | 5.3 | 99.5 |
| 1968 | 934.6 | 69.5 | 31.9 | 4.3 | 105.7 |
| 1969 | 913.6 | 72.1 | 34.0 | 5.7 | 111.8 |
| 1970 | 1077.5 | 89.8 | 26.2 | 10.0 | 126.0 |
| 1971 | 1161.4 | 72.1 | 76.6 | 9.6 | 158.3 |
| 1972 | 976.5 | 77.5 | 85.5 | 11.6 | 174.6 |
| 1973 | 1221.9 | 136.9 | 67.0 | 12.6 | 216.5 |
| 1974 | 1128.6 | 112.00 | 55.2 | 15.9 | 183.1 |

Source: Central Marine Fisheries Research Station, Mandapam Camp, India approximately 200 freezing and 60 canning plants with an installed capacity of 977 and 229 tonnes per day respectively; the chain of frozen storage units (numbering about 270) has an installed capacity of 22,000 tonnes. Most of the processing establishments (about 100 freezing plants and 36 canning plants) are in Kerala.

Shrimps are almost exclusively quick frozen in horizontal plate freezers which are capable of cooling closely wrapped packs from 0 to 5°C in a period of two hours or less. Subsequently, the temperature is further lowered until at least the recommended temperature of frozen storage is reached.

## Quality control system

When the export markets changed to countries such as the USA, Japan, Australia, the UK and the other European countries which are very quality conscious, it became increasingly necessary to enforce measures to ensure quality standards. The Indian Government enacted legislation entitled 'The Export (Quality Control and Inspection) Act 1963' which came into force on 1 January 1964. Fish products, being very sensitive commodities, have statutorily been brought under the compulsory quality control and pre-shipment inspection scheme. This was entrusted to the Export Inspection Council, a statutory body set up by the Government in January 1964.

Canned and frozen shrimp came under the compulsory inspection scheme in March 1965, dried prawns in June 1970 and frozen lobster tails by December 1971. In the beginning, standards were confined to physical and organoleptic characteristics (eg size, weight, texture, odour, dehydration, discolouration, black spot, broken and damaged pieces, presence of foreign matter etc). The bacteriological standards were gradually enforced from January 1968.

The bacteriological standards for *Escherichia coli* and pathogenic bacteria (salmonellae and staphylococci) for frozen shrimp and frozen lobster tails were introduced from August 1973. Table 4 gives bacteriological standards for different products; the total plate count of 1.0 x $10^6$, instead of 0.5 x $10^6$ which is the notified limit, is only tentative.

In addition, the Marine Products Export Development Authority, another statutory body under the Government, has drafted standards for fishing vessels, processing plants, storage premises, peeling centres and transport vehicles through a notification in January 1975. The standards came into force from April 1975. The requirements under these standards are very elaborate and specific; some of the important provisions are listed below.

1. A suitable detergent, followed by disinfection using chlorine of 100 ppm strength, should be used for cleaning all utensils and surfaces that come in contact with fish.
2. Fishing boats should carry ice prepared from potable water/clean sea water.
3. Processing plants or pre-processing/peeling centres should have a plentiful supply of potable water, chlorinated to a residual level of 10 ppm. Only this water should be used at different stages of processing.
4. Ice should be prepared from chlorinated water (10 ppm).
5. Factory personnel should be properly clothed while on duty. They should wear clean overalls and head coverings and should be trained for high standards in both personal and plant hygiene.
6. Plant management should take care to ensure that no person, while known to be affected with an infectious disease, is permitted to work in any area of the unit. Quarterly medical examination of personnel is desirable.

For the maintenance of proper hygiene within the fishing industry, the Indian Standards Institution (a government organization entrusted with the work of formulating standards and specifications for Indian products and commodities) has provided the industry with necessary guidelines, in the form of different standards.

## Mercury contamination

During May and June 1973, there were reports in the Japanese press about serious contamination of marine products, especially by mercury. The Japanese Government issued necessary guidelines to its people

**TABLE 4.** *Bacteriological standards for frozen shrimp and lobster tails*

| *Product* | *Total plate count x $10^6$/g at 37°C* | *E. coli count/g (maximum)* | *Coagulase positive staphylococci count/g (maximum)* | *Salmonellae and other pathogenic bacteria/g* |
|---|---|---|---|---|
| Frozen shrimp (shell-on type) | 0.5 | 20 | 100 | nil |
| Frozen shrimp (cooked type) | 0.1 | nil | 100 | nil |
| Frozen shrimp (peeled and de-veined type) | 1.0 | 20 | 100 | nil |
| Frozen lobster tails | 0.5 | 20 | 100 | nil |

restricting the consumption of prawn/shrimp to 6.6 per person per week. The US Food and Drug Administration (FDA) has set 0.5 (or less) ppm as the safe level of mercury in foods. Since Japan and the USA are our main buyers of frozen shrimp, it was considered necessary to have the data on the mercury content of Indian shrimp. The Bhabha Atomic Research Centre (India) analysed samples of prawns collected from different landing centres in India.

The analysis revealed that the mercury level of Indian shrimp/prawn is within (and far below) the safety limits. The mercury concentration of prawn and lobster from the Bombay coast is given in Table 5. A co-ordinated research programme to ensure quality of marine products in relation to toxic elements has been initiated.

TABLE 5. *Mercury content of prawn and lobster from the Bombay coast*

| *Common name* | *Scientific name* | *Concentration of mercury (ppb) on fresh weight basis* |
|---|---|---|
| Prawn | *M. affinis* | 130 ± 10 |
| Lobster | *Panularis polyphagus* | 100 ± 15 |

## Marketing of Indian shrimp

Although India is one of the largest frozen shrimp suppliers in the world, this fact is not generally well recognized. This is because Indian frozen shrimp are exported in 5 lb and/or 2 kg institutional packs, which are reprocessed or repacked, particularly in the USA. The Indian product has lost its identity when it ultimately reaches the consumer while shrimp imported from other countries are marketed without repacking.

The liquid nitrogen-individually quick frozen (LN-1QF) shrimp appear to fetch the highest price on the sophisticated market. Indian shrimp are essentially frozen in plate freezers and, therefore, do not command a good price. In the USA, frozen shrimp from India are thawed and refrozen by IQF prior to marketing. It may therefore, be necessary to adopt this technology (LN-IQF).

## Diversification of the processed products

Instead of confining exports to three or four types of frozen shrimp, it may be advantageous to diversify the product profiles with a view to expanding the marketing base. The ready-to-eat convenience products such as breaded shrimps, soups, salads etc may find a ready acceptance with the consumer. It may also be worthwhile introducing appropriate consumer packs in place of institutional packs for better monetary returns. However, before attempting to introduce new products into the market, it may be necessary to elicit consumer reaction to these by conducting test marketing trials. This diversification would create a stable and lasting market in the developed countries. A campaign may also be necessary in the importing countries to promote the quality and other characteristics of Indian shrimp products.

## Conclusions

During the last fifteen years India has made substantial progress in fish catching and processing. All this development has been possible due to the increased export of frozen shrimp. However, dependance on a single raw material resource and markets limited to a few countries are the inherent weaknesses of the frozen shrimp industry. The essential steps in keeping this industry in a healthy condition are: increasing the supplies of raw material (shrimp), either by culture or exploring a new area; the introduction of better technology for freezing; packing of canned products conforming to the liking of consumers in the developed countries; diversification of the products. The industry, Government Departments, research institutions and other agencies are very much aware of all these problems and are planning programmes and strategies to solve them.

# The European market for tropical prawns

**N. W. Young**
Young's Seafoods Ltd, UK

## Summary

The current position in the European, and particularly the UK, markets is reviewed and the prospects for growth in the trade are indicated.

The importance of quality is emphasized. The poor practices and slack controls of some tropical producers, which have led to large-scale rejections of certain products, and the means of improving quality are discussed. The need for a consistent supply situation is also considered important.

The marketing requirements of the European importers are illustrated and the paper concludes by suggesting that tropical producers who take steps to improve quality can reap considerable benefits in the longer term.

## Résumé

La position habituelle sur le marché Européen et particulièrement sur le marché du Royaume Uni est passée en revue ainsi que les projets de développement commercial.

L'importance de la qualité est soulignée. Les pratiques défectueuses et l'absence de contrôle de ceertains producteurs tropicaux ont provoqué des refus importants de certains produits et les moyens d'amélioration de la qualité sont discutés. Le besoin d'un approvisionnement consistant est également considéré comme essentiel.

Les exigences du marché des importateurs Européens sont mises en évidence et l'article conclut en suggérant que les producteurs tropicaux qui prennent des mesures pour améliorer la qualité de leurs produits pourraient obtenir des avantages considérables à long terme.

## Resumen

Se hace una revisión de la situación actual de los mercados europeos, y en particular del Reino Unido, y se indican las perspectivas de crecimiento comercial.

Se da especial importancia a la calidad. La baja calidad de las prácticas y los negligentes controles de algunos productos tropicales han llevado al rechazo en gran escala de ciertos productos, discutiéndose también los medios para mejorar la calidad. También se considera importante la necesidad de una situación de suministro constante.

Se citan las exigencias comerciales de los importadores europeos y el artículo concluye sugiriendo que los productores tropicales, que tomen medidas para mejorar la calidad pueden obtener considerables beneficios a largo plazo.

## Introduction

In my paper I shall be covering certain aspects of the European and particularly the UK markets as they exist today. I shall also indicate areas where potential market growth may exist in the future for tropical prawns.

## Species imported

The European and UK markets now import a fairly wide range of prawns which, in the main, are purchased in two forms:

### *Raw headless shell-on*

The larger grades, consisting of graded tails of 35 counts per lb and larger, are most popular with the bulk of the market. However, purchases are made in less volume down to 80 counts per lb. Sea-water species are the most popular but freshwater prawns are also imported.

Headless shell-on prawns are imported from China, Australia, India, Malaysia, Pakistan, West and East Africa and South America. Banana, tiger, pinks and kings are popular species imported. Nearly all the headless shell-on products are delivered in 5 lb or 2 kg blocks, usually with six blocks to the outer case.

There is a potential market within Europe for a retail pack of 500 g but it is difficult to persuade the producers to pack into such small units. Possibly we are all too late now as the world price for bulk packs has reached such a high level that the launching of a small, more expensive retail pack would almost certainly fail.

### *Cooked and peeled prawns*

These are equally important in the overall imports and consist of packs usually graded as follows:

100–200 counts per lb
200–350 counts per lb
350–500 counts per lb

Some of the species handled require de-veining at the production stage in order to give an attractive presentation. In recent years there has been a marked swing away from block frozen packs to Individually Quick Frozen (IQF) prawns. The IQF method of freezing gives the consumer greater flexibility.

Peeled prawns of the pink species are imported in large quantities from the Far East and, of the small tropical prawns fished, the pinks are preferred by the European customers. The sand shrimp, on the other hand, has a less attractive appearance and requires de-veining.

As a result of the strict health controls on imported cooked and peeled prawns, there has been a growth in the demand for raw de-veined prawns which will be cooked and packed in European factories. However, this method of processing can never be as efficient as a well-organized producer at the source of supply. Some larger importers purchase bulk packs in order to give flexibility at the market place.

## The importance of quality

It is a fact that thousands of seafood producers in both cold and tropical climates have gone out of business due to insufficient attention towards standards of hygiene and quality of their production.

Seafoods must be handled with the greatest possible care if the high value, which the markets will pay for prawns, is to be maintained. There have, however, been sufficient examples, in recent years, of market weakness through the failure of a number of producers to meet reasonable standards of quality control. The cooked and peeled prawn market is a typical example; poor practices and slack controls have led to a spate of rejections by health officers in many countries.

Management controls must be carried out at all stages. Wherever the prawns come into contact with boxes, conveyor belts, trays and, of course, human beings, then all these points of contact must be correctly cleaned at regular intervals. The product must at all times be kept in a cool state; likewise it is extremely important to reduce the temperature rapidly after cooking.

The employees and management who work within the factories must all be controlled to ensure that no contamination is carried from the toilets or outside. I also believe that no shellfish factory should be established in the tropics without an accompanying laboratory and trained staff to operate it. Consistency in quality can be achieved only by thorough and continuous hard work; the factory which follows good practices must do well in the long run, since they will be the company to obtain the best orders from the larger European buyers.

In recent years the freezer trawler has played an increasingly important role. Controls are, however, often more difficult to enforce and the very nature of the smaller freezer trawlers limits the production to whole raw or headless raw and sometimes whole cooked prawns. Because most of the production goes for further processing ashore, it is important to ensure that high standards of hygiene are practised on the freezer trawlers and indeed any fishing vessel: likewise good temperature control is important.

## Consistent supply

Once the well-established importer has made sure that the factories he is buying from can consistently meet his quality requirements, then the next problem is continuity of supply. This is a major problem to marketing companies in our industry but it can be resolved on a reasonably successful basis if the following approach is adopted.

The marketing company must give a clear indication of their projected sales and, in conjunction with the producer, a buying programme covering the fishing season is then established. The marketing company undertakes to hold sufficient stocks to carry their sales through to the next season. The more accurate the planning the greater will be the success for both producer and seller.

## Marketing requirements

### *Raw headless shell-on prawns*

As already mentioned, there is some scope for smaller packs. There is also a limited demand for a peeled and de-veined product, which is often used in manufacturing. Likewise a small demand exists for the butterfly presentation.

The raw, whole prawn is beginning to be imported and it is possible that this form of presentation could help to cut costs and give an attractive presentation to the market. However, close attention must be given to the methods of freezing and packing the whole prawns to avoid damage.The product must also be extremely fresh when frozen.

### *Cooked and peeled prawns*

I would recommend that efforts be concentrated on producing high quality produce and ensuring that your products will meet the importing country's health controls. There is a substantial market in the UK and Europe but in recent years a great deal of harm has been caused through health control rejections. Those producers responsible for packing these prawns must put their houses in order before they can hope for a better cooked and peeled prawn market.

## Market resistance and opportunity

The average European prefers the locally caught prawns, scampi and shrimps to the imported tropical prawns. The reason for this is that he has grown to like the tender sweet flavour of cold-water shellfish. Tropical prawns have completely different characteristics and require different styles of cooking and presentation.

Thus, the market growth has really developed through the Chinese and Indian restaurant traders who appreciate and understand how to present tropical prawns. Without doubt some European restaurants, amazed at the growth of oriental restaurants, have tried to market headless shell-on prawns but there are very few that have been successful.

Tropical cooked and peeled prawns, on the other hand, have been successfully introduced into the European restaurant. Whilst the cold-water species are preferred, the cost savings to a restaurant of the tropical cooked and peeled prawn are significant; they are also better suited for curry dishes, having a tougher texture than the delicate *Pandalus* species which tend to fall apart.

Prices will improve significantly when the producers of tropical cooked and peeled prawns rid their industry of those sections which set standards unacceptable to the European market. There has been a great deal of bad publicity, much of it deserved, and no industry can stand continuous poor publicity. Our standards in Europe may be different from those practised in tropical countries but, if you wish to see more prawns marketed in the UK and Europe, then standards have to improve in many of the production plants. Those that have put their house in order will reap long-term benefits as buyers become more critical and participate with the producer in giving technical advice and guidance to the benefit of both producer and the final customer.

# Bacteriology of shellfish with reference to international trade

**D. C. Cann**
Torry Research Station, UK

## Summary

Today, shellfish products in international trade must not only be competitive in terms of price and eating quality but must also meet the bacteriological requirements of importing health authorities.

The number and types of bacteria present in a shellfish product will reflect the changes that have taken place in the initial flora and contamination that may occur during catching, handling and processing. Consequently, the development of an export industry depends on a thorough knowledge of the bacteriology of the products to be marketed so that adequate quality control can be applied.

In this paper the existing knowledge of the bacteriology of shellfish is reviewed and additional data are presented. Processing procedures are appraised and areas where more effective quality control may be applied are indicated. The bacteriological indices used in quality control are listed and their worth is evaluated from both quality and public health aspects. Some current bacteriological limits and standards for shellfish products are presented and their implications discussed.

## Résumé

Actuellement, les coquillages sur le marché international doivent non seulement être compétitifs en prix et en qualité gastronomique, mais ils doivent également être conformes aux exigences bactériologiques des authorités sanitaires des pays importateurs.

La nombre et le type des bactéries se trouvant dans les coquillages sont en relation avec les modifications qui se sont produites dans la flore initiale et avec les contaminations qui peuvent survenir au cours de la pêche, de la manipulation et de la préparation. En conséquence, le développement d'une industrie exportatrice est lié à une connaissance complète de la báctériologie des produits qui doivent être commercialisés de telle sorte que soit appliqué un contrôle adéquat de qualité.

Dans cet article, les connaissances actuelles concernant la bactériologie des coquillages sont passées en revue et des données supplémentaires sont présentées. Les méthodes de préparations sont évaluées et les zones où un contrôle de qualité plus efficace peut être appliqué sont indiquées. Les indices bactériologiques utilisés dans le contrôle de qualité sont énumérés et leur valeur déterminée à la fois en ce qui concerne leur qualité et en ce qui concerne la protection de la santé publique. Certaines limites et normes bactériologiques courantes s'appliquant aux coquillages sont présentées et leurs implications sont discutées.

## Resumen

Hoy día, en el mercado internacional los mariscos deben ser competitivos no solamente en cuanto al precio y la calidad comestible, sino que deben también cumplir los requisitos bacteriológicos de las autoridades sanitarias importadoras.

El número y tipos de bacterias presentes en los mariscos reflejarán los cambios que han tenido lugar en la flora inicial y la contaminación que puede tener lugar durante la pesca, la manipulación y la elaboración. Consiguientemente, el desarrollo de la industria exportadora depende del conocimiento completo de la bacteriología de los productos que se comercializan, de modo que se puede aplicar un control adecuado de calidad.

En este artículo se hace una revisión de los conocimientos actuales de la bacteriología de los mariscos y se presentan datos adicionales. Se consideran los procedimientos de elaboración y se indican las zonas donde se puede aplicar un control de calidad más efectivo. Se enumeran los índices bacteriológicos utilizados en el control de calidad y su valor, tanto desde el punto de vista de la sanidad pública como de la calidad. Se presentan algunos límites bacteriológicos actuales y normas para productos marisqueros, así como sus implicaciones.

International trade in tropical shellfish products has risen steadily in recent years. Improved fishing methods and increased use of refrigeration have enabled more countries to develop export markets which have become important to national economies both as sources of foreign exchange and in providing employment. The maintenance and further expansion of these markets are becoming increasingly dependent not only on traditional commercial factors but also on the bacteriological quality of products, as the role of fish foods in the transmission of disease becomes recognized (WHO, 1974). Inspection by public health authorities has become more necessary as new products enter the markets; particularly if they originate from countries with specific endemic diseases. In addition, many of the more progressive importing firms, zealous in the protection of their brand name, impose tight bacteriological specifications on products purchased for their own use. In a seller's market, non-compliance with specifications may be overlooked when demand is high, but, in times of recession they may be rigidly applied with consequent heavy losses to any industry where standards are slack.

The development of shellfish products must, therefore, take into account the bacteriological specifications, limits and standards that are required by potential foreign importers and, realistic appraisal, of whether or not those requirements can be met, must be made by all sections of industry and government concerned. To do this, a thorough knowledge of the bacteriology of the specific shellfish must be obtained at all stages of catching, handling and processing.

Shellfish in their natural environment carry a commensal bacterial load, the composition of which may be governed by such factors as their feeding and living habits, the geography of the area, the seasons, and the temperature and quality of the waters in which they exist. Deep-sea species caught in clean waters can be expected to carry only marine bacteria, whereas inshore species collected from littoral or sub-littoral zones which are subject to pollution may, in addition, carry significant numbers of terrestrial types. During catching and handling, contamination will occur as a result of contact with man and the common food-borne pathogens may be acquired.

The bacterial load on catches of shellfish can, therefore, vary considerably and the quality and wholesomeness of the catch will depend on the numbers and types of bacteria present and on how they are controlled during processing and marketing.

## Natural flora of shellfish

### *Crustaceans*

When considering the numbers and types of bacteria occurring naturally on shellfish it is difficult to exclude the effect of contact with the gear and deck of the catching vessel. Counts of around $10^4$–$10^8$ per $cm^2$ have been reported to build up on deck surfaces during a fishing trip (Iyer *et al.*, 1971; Castell, 1973). Few data are available on the bacterial content of shellfish examined directly from the sea and most data presented are for freshly landed shellfish. Figures for total viable counts on temperate and cold-water crustaceans range between $10^3$–$10^7$ per gram at an incubation temperature of 20°C with counts at 37°C showing a similar pattern but usually one order of magnitude lower. Thus Green (1949 a and b), Fieger (1950) and Fieger *et al.* (1956) published counts (at 20°C) of $10^4$–$10^7$/g for shrimp from the Gulf of Mexico; Tobin and McCleskey (1941), $10^4$–$10^6$/g for Louisiana crab whilst workers at Torry Research Station (TRS), studying British species, reported counts of $10^3$–$10^6$/g for scampi (*Nephrops norvegicus*) (Walker *et al.*, 1970; Cann *et al.*, 1971); $10^3$–$10^6$/g for crab (*Cancer pagurus*) (Early, 1967; Torry Research Station unpublished results); $10^4$–$10^7$/g for the deep-water shrimp (*Pandalus borealis*) and $10^4$–$10^5$/g for the inshore shrimp (*Pandalus montagui* and *Crangon crangon*).

The bacterial flora of tropical species of crustaceans differs from that of cold-water species; it is largely mesophilic due to an environmental temperature of 25–30°C (Cann, 1971; Newell, 1973). Initial total viable counts will, therefore, be most relevant if carried out at incubation temperatures of 30–37°C. Counts reported for prawns in India range from $10^4$–$10^7$/g (Venkatamaran *et al.*, 1953; Pillai *et al.*, 1961; Jacob *et al.*, 1962); in Thailand from $10^3$–$10^6$/g (Cann, 1971); in northern Australia $10^3$–$10^5$/g (Ruello, 1974) whilst in Malaysia counts were significantly higher at $10^6$–$10^7$/g even when shrimp were collected at sea directly from the nets of trawlers (TPI, personal communication).

The major groups of bacteria comprising the flora of crustacean shellfish are *Micrococcus*, coryneforms, *Moraxella/Acinetobacter* (previously classified together as *Achromobacter*), *Pseudomonas* and to a lesser extent *Flavobacterium/Cytophaga* and *Bacillus*. The percentage composition varies. Williams *et al.* (1952a) found the main groups in whole Gulf shrimp to be *Achromobacter*, *Micrococcus*, *Pseudomonas* and *Bacillus* whereas Sreenivasan (1959) indicated that prawns in India carried a predominantly micrococcal and corynebacterial flora.

Tables 1 and 2 show flora studies of freshly landed crustaceans which largely consisted of either *Achromobacter* spp. or the gram-positive *Micrococcus* and coryneform groups. Gram-negative organisms of the *Achromobacter* and *Pseudomonas* group were significantly present in the cold-water types but were of lower incidence in the tropical types.

Harris (1932) found that the major types of bacteria in crab were gram-negative asporogenic rods and streptococci with smaller numbers of *Pseudomonas*, *Flavobacterium*, *Micrococcus* and *Sarcina*. Alford *et al.* (1942) reported that *Micrococcus* predominated in the flora of Louisiana crab, whereas Early (1967), investigating North Sea crab, and Lee and Pfeifer (1975), investigating Pacific crab, found that *Achromobacter* was predominant in both the flesh and intestine (Table 1).

TABLE 1. *Bacterial flora of fresh temperate shellfish (%)*

| *Shellfish* | *Source* | *Pseudomonas* Gp I | *Pseudomonas* Gp II | *Pseudomonas* Gp III | *Pseudomonas* Gp IV | Coryneforms | *Achromobacter* | Micrococci | Streptococci | *Flavobacterium/ Cytophaga* | Enterobacteriaceae | *Aeromonas* | *Vibrio* | *Bacillus* | Yeast/*Streptomyces* | *No growth | Unidentified |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHRIMP (Prawn) | | | | | | | | | | | | | | | | | |
| *Pandalus borealis* | North Sea | – | 4 | 9 | 1 | 63 | 12 | 7 | – | – | – | – | – | – | – | 4 | – |
| *P. borealis* | | – | – | 11 | 3 | 24 | 28 | 6 | – | 26 | – | – | – | – | – | – | 2 |
| *P. montagui* | | – | – | 6 | – | 18 | 49 | 8 | – | 12 | – | 2 | – | 3 | – | 2 | – |
| *Crangon crangon* | | – | – | 14 | – | 20 | 46 | 7 | – | 7 | – | 1 | – | 3 | 1 | 1 | – |
| SCAMPI ** | | | | | | | | | | | | | | | | | |
| *Nephrops norvegicus* | North Sea/Irish Sea | 4 | 2 | 3 | 2 | 42 | 17 | 8 | 7 | 10 | 1 | 1 | – | 1 | – | 2 | – |
| CRAB | | | | | | | | | | | | | | | | | |
| *Cancer pagurus* (flesh)[1] | North Sea | – | – | – | – | 9 | 68 | 23 | – | – | – | – | – | – | – | – | – |
| *C. pagurus* (intestine) | | – | 2 | – | – | 6 | 70 | 15 | – | – | 7 | – | – | – | – | – | – |
| *Cancer magister* (flesh)[2] | Pacific Ocean | 18 | | | | 3 | 60 | 2 | – | 6 | – | – | 7 | – | – | – | 4 |
| *C. magister* (intestine) | | 16 | | | | 15 | 44 | 9 | 2 | 6 | – | – | 5 | 2 | – | – | 2 |
| *C. magister* (intestine) | | 18 | | | | 3 | 40 | 2 | – | 6 | – | – | 7 | – | – | – | 4 |
| *C. magister* (intestine) | | 26 | | | | 11 | 56 | – | – | 1 | – | – | – | – | – | – | 6 |
| QUEENS [3] | | | | | | | | | | | | | | | | | |
| *Chlamys opercularis* | Irish Sea | 16 | | | | 17 | 22 | 22 | | 12 | 2 | – | – | – | – | 7 | 3 |
| COCKLES | | | | | | | | | | | | | | | | | |
| *Cardium edule* | North Sea | – | – | 17 | – | 13 | 14 | 30 | – | 7 | 1 | 5 | – | 4 | 3 | 6 | – |

* 'No growth' refers to primary isolates not viable on sub-culture

** Average of 19 analysis

1. Early, 1967
2. Lee and Pfeifer, 1975
3. Thomson *et al.*, 1974

TABLE 2. *Bacterial flora of fresh tropical shellfish (%)*

| *Shellfish* | *Source* | *Pseudomonas* Gp III | Coryneforms | *Achromobacter* | *Micrococcus* | *Flavobacterium/ Cytophaga* | Enterobacteriaceae | Streptococci | *Aeromonas* | *Bacillus* | Streptomycetes | *No growth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHRIMP (Prawn) | | | | | | | | | | | | |
| *Penaeus* spp.** | Gulf of Thailand | – | 13 | 15 | 38 | 20 | – | – | – | 8 | – | 6 |
| *Metapenaeus* spp.** | | 1 | 55 | 5 | 24 | – | 3 | – | 1 | – | 9 | 2 |
| *Parapeneopsis* spp. | Straits of Malacca | – | 17 | 33 | 38 | 7 | – | 5 | – | – | – | – |
| *Parapeneopsis* spp. | | 17 | 7 | 26 | 39 | 11 | – | – | – | – | – | – |

*'No growth' refers to primary isolates not viable on sub-cultures
**Cann, 1974a

### *Mollusca*

Bacteriological investigation and control of molluscs is usually conditioned by the form in which they are marketed and eaten. Deep-water species such as scallops and queens, which are fully processed, receive the full spectrum of analysis; whereas the estuarine varieties, oysters, clams and mussels, although they are often marketed live and eaten raw, are commonly examined for their *Escherichia coli* content only. Deep-water species, whether tropical or non-tropical, can be expected to carry lower bacterial loads than estuarine species which live in comparatively warmer waters more subject to pollution.

In the United Kingdom, examination of queens (*Chlamys opercularis*) and scallops (*Pecten maximus*) showed that they have total viable counts ranging from $10^3-10^6$/g at 20°C and $10^3-10^5$/g at 37°C (TRS, unpublished results). In comparison, oysters (*Ostrea edulis*), hard clams (*Mercenaria mercenaria*), cockles (*Cardium edule*) and mussels (*Mytilus edulis*) carried total viable counts of $10^3-10^8/\text{cm}^3$ both at 20 and 37°C with between 42 and 51% of the counts in excess of $10^6/\text{cm}^3$ of tissue macerate (Ayres, 1975a; TRS, unpublished results).

Few studies have been made of the flora of molluscs. Work on deep-water species carried out at Torry indicates that, although the types of bacteria present are similar to those found in crustacean shellfish, the percentage composition is very variable. Thomson *et al.* (1974), in a single study of freshly caught queens, showed that *Micrococcus, Moraxella* and coryneforms comprised the bulk of the flora (Table 1).

## Spoilage flora

From the time of catching, bacteriological spoilage of all shellfish products is inevitable, unless, at some time in the processing sequence, they are either heat sterilized or frozen and stored below –4°C. The rate and type of spoilage will vary with the time and temperature of storage. Whilst all fishery products should be either frozen or chilled to 0°C immediately after catching, it is of paramount importance with tropical products: because the temperature of the sea from which they are taken is relatively high and because the ambient temperatures are higher, they are doubly susceptible to spoilage. Firstly, by mesophilic bacteria until cooled from their initial temperature of 25–30°C to below about 15°C; and secondly, by psychrophilic bateria from 20°C to 0°C. However, provided they are properly chilled, there is steadily accumulating evidence of an extended shelf life for tropical fish and shellfish in comparison with cold-water species (Shewan, 1977). Storage studies of iced shrimp in India (Iyengar *et al.*, 1960) and Thailand (Cann, 1971) showed a storage life of up to 16 days whereas non-tropical crab (Early, 1967), scampi (Walker *et al.*, 1970), queens (Thomson *et al.*, 1974) and shrimp (TRS, unpublished results) were all totally spoiled after 8–10 days. Such marked differences in shelf life may be explained by examination of their relative flora. The mesophilic flora initially present in tropical shellfish will not grow at the temperature of melting ice. Consequently, spoilage will be delayed until a psychrophilic flora develops. Moreover, *Pseudomonas* and *Moraxella/ Acinetobacter* species, which are considered to be the active bacterial spoilage agents in iced fishery products, are not as numerous in tropical as in temperature shellfish (Shewan and Hobbs, 1967; Castell, 1973). Total viable counts on shellfish after spoilage in ice are of the order of $10^7-10^8$/g at 20°C with the flora dominated by one or the other of the gram-negative *Pseudomonas* or *Moraxella/Acinetobacter* genera (Tables 3 and 4), although it is probable that even within this group only a relatively low proportion of the total numbers are active spoilage agents (Shewan, 1977).

## Organisms of public health significance

Within this group of bacteria are those organisms which, when present in foods, either present a direct food-poisoning hazard or, because of their close association with food-borne pathogens, act as indicators of their presence. The most commonly used 'indicator organisms' in international trade in shellfish are *Escherichia coli* (or faecal coliforms) and *Staphylococcus aureus*.

Shewan (1970) in a comprehensive review of the food-poisoning hazard in fishery products stated that, with certain reservations, they are still amongst the safest

TABLE 3. *Bacterial flora of spoiled temperate shellfish (%)*

| *Shellfish* | *Source* | *Days' storage in ice* | *Pseudomonas* Gp I | *Pseudomonas* Gp II | *Pseudomonas* Gp III | *Pseudomonas* Gp IV | Coryneforms | *Achromobacter* | Micrococci | *Flavobacterium/ Cytophaga* | Enterobacteriaceae | *Aeromonas* | *No growth | Unidentified |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHRIMP (Prawn)<br>*Pandalus borealis* | North Sea | 5 | – | – | – | – | 6 | 80 | 5 | 2 | – | – | 2 | 5 |
| | | 7 | – | 24 | – | – | – | 37 | – | 12 | 10 | 1 | – | 16 |
| SCAMPI[1]<br>*Nephrops norvegicus* | North Sea/Irish Sea | 8 | – | – | – | – | 13 | 72 | – | – | 1 | – | – | 14 |
| | | 10 | 4 | 3 | 1 | – | 19 | 70 | 2 | 1 | – | – | – | – |
| | | 10 | 2 | 5 | 59 | 16 | – | 14 | 2 | 2 | – | – | – | – |
| | | 10 | – | 18 | 52 | 10 | – | 8 | 1 | 3 | – | 7 | 1 | – |
| | | 10 | – | – | 66 | 15 | 3 | 10 | – | – | 1 | – | 5 | – |
| QUEEN[2]<br>*Chlamys opercularis* | Irish Sea | 8 | 8 | | | | 2 | 90 | – | – | – | – | – | – |

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* 'No growth' refers to primary isolates not viable on sub-culture

1. Walker *et al.*, 1970; Cann *et al.*, 1971

2. Thomson *et al.*, 1974

TABLE 4. *Bacterial flora of spoiled tropical shellfish (%)*

| *Shellfish* | *Source* | *Days' storage in ice* | *Pseudomonas* Gp II | *Pseudomonas* Gp III | *Pseudomonas* Gp IV | Coryneforms | *Achromobacter* | Micrococci | *Flavobacterium/ Cytophaga* | Enterobacteriaceae | *Aeromonas* | *Bacillus* | Streptomycetes | *No growth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHRIMP (Prawn) | | | | | | | | | | | | | | |
| *Penaeus* spp. | Gulf of Thailand | 16 | 87 | 3 | 1 | – | 4 | – | – | – | 1 | – | – | 4 |
| *Penaeus* spp. | Mozambique | 12 | – | 1 | 4 | 19 | 67 | – | 8 | – | – | 1 | – | – |
| *Penaeus* spp. | Malaysia | 12 | 3 | 4 | 1 | 41 | 48 | 1 | – | 1 | – | 1 | – | – |
| *Metapenaeus* spp. | Gulf of Thailand | 11 | 50 | 6 | 1 | 14 | 8 | 11 | – | 2 | – | 5 | – | 3 |

Source: Cann, 1974a
*'No growth' refers to primary isolates not viable on sub-culture

articles of food. He further stated, after examination of a wealth of data from published work in the USA and Europe, that the flora of freshly caught wet fish is virtually free from pathogens; coliforms are never present in excess of $10^2$/g, and *E. coli* and *S. aureus* occur infrequently and in small numbers only.

Further work in the United Kingdom on shellfish supports the earlier views of Shewan. Examination of over 455 samples of crustaceans and deep-water molluscs, taken at various stages of commercial production, has never yielded *Salmonella* but counts for *E. coli* of up to 190/g and *S. aureus* 800/g have been found. These organisms were not detected in 55 and 66% respectively of the samples tested (TRS, unpublished results). In addition, Ayres (1975b) working on estuarine bivalve molluscs found 92.8% contained less than 2 *E. coli*/$cm^3$.

The picture in tropical shellfish is more variable. Although freshly caught penaeid shrimp do not carry either *E. coli* or *S. aureus*, smaller inshore shrimp of *Parapeneopsis* spp. and *Trachypenaeus* spp., collected at sea, were consistently contaminated with *E. coli*. On one occasion a sample taken from the net of a trawler contained *E. coli* at $>90$/g and *S. aureus* at a level of 50/g. *Salmonella* was never found (TPI, personal communication).

In any consideration of the incidence and significance of bacterial hazards from the eating of shellfish, two organisms require special mention: these are *Clostridium botulinum* and *Vibrio parahaemolyticus*. Both have been the subject of specialist reviews; *Cl. botulinum* by Hobbs (1976) and *V. parahaemolyticus* by Liston (1973) and Barrow (1973 and 1974).

*Clostridium botulinum* is widely distributed throughout the world in freshly caught fish and shellfish. It has not, however, been sought extensively in the tropics but types A and C have been isolated from penaeid shrimp in the Gulf of Darien (Carroll *et al.*, 1966), types B, C and F from octopus, crab and shrimp respectively in Indonesia (Mortojudo *et al.*, 1973) and types E and D from squid in Thailand (Tansaugarn, 1970).

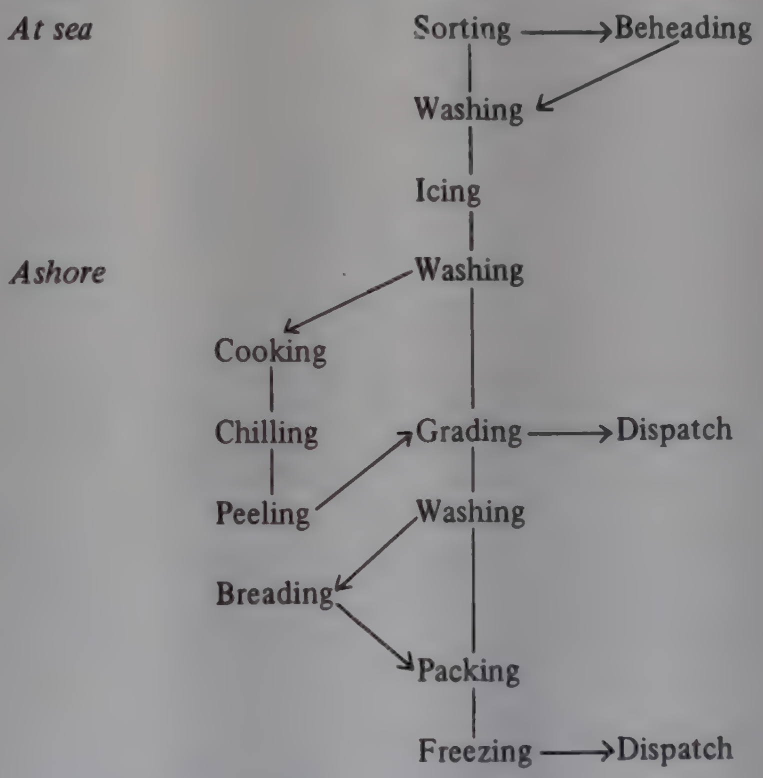
*Vibrio parahaemolyticus*, a true marine organism, has become increasingly recognized as a food-poisoning agent in many countries, since its original isolation in Japan in 1951. Its prevalence in temperate regions, however, appears to be seasonal and restricted to warmer, inshore waters particularly where the organic content is high. The work reported here on tropical shrimp illustrates this pattern. Although *V. parahaemolyticus* was not found on shrimp caught on the deeper Thai fishing grounds, in Malaysia it was isolated from 7 of 10 samples collected at sea off the island of Penang, from 8 of 12 samples taken at different landing places and, overall, from 17 of 54 samples taken during catching, handling and processing procedures. The serotypes of ten of the isolates are shown in Table 5; seven could not be typed. *V. parahaemolyticus* was not isolated from 455 samples of temperate shellfish. Moreover, an intensive examination of 140 crabs, caught commercially off the Devon and Cornish coasts of England, yielded only one positive isolate despite the presence of the organism in 10 of 47 samples of sand and sea water examined from the area.

TABLE 5. *Serotypes of* Vibrio parahaemolyticus *isolated from Malaysian shrimp*

| *Sample* | *O type* | *K type* | *Kanagawa reaction* |
|---|---|---|---|
| Raw, shell-on | 4 | 34 | negative |
| | 4 | 42 | ,, |
| | 8 | 22 | ,, |
| | 1 | 1 | ,, |
| Raw, peeled | 4 | 55 | ,, |
| | 4 | 42 | ,, |
| | 1 | 38 | ,, |
| Cooked, shell-on | 4 | 55 | ,, |
| Cooked, peeled | 7 | 19 | ,, |
| Cooked, frozen | 1 | 38 | ,, |
| Packaged | 1 | 38 | ,, |

## Effect of processing

If primary contamination of shellfish can be said to occur up to the time of catching then secondary contamination begins at the start of processing. With some variations and omissions, notably with bivalve molluscs marketed raw in the shell, the main stages in processing are:



Processing necessarily involves handling, with the inevitable introduction of bacteria of human origin. These bacteria may be 'non-specific' or potential food-poisoning pathogens. Machine processing is steadily being introduced at all stages of production but exposure to human contamination cannot be entirely excluded. For the control of contamination in the shellfish processing industry, the standard of hygiene that is practised must, therefore, be first and foremost in importance. The general requirements for the maintenance of hygiene and quality in shellfish processing are very similar for temperate and tropical products and are well documented (FAO/WHO 1969; WHO 1974; FAO 1975a and b).

During processing, the numbers and types of bacteria present on products will fluctuate within a given sequence. Counts generally fall at washing, cooking and freezing stages and rise during sorting, peeling, grading, breading and packing.

TABLE 6. *Total viable counts (organisms/g, at 20°C) of shrimp stored in ice*

| *Fishing area (Port of landing)* | *Genus* | *Days' storage* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 5–6 | 8–9 | 10 | 12 | 14 | 16 | 18 |
| Gulf of Thailand (Songkhla) | *Penaeus* | | | | | | | | | |
| | whole | $7.9 \times 10^{4}$ | – | $4.2 \times 10^{6}$ | $5.6 \times 10^{6}$ | – | $3.1 \times 10^{8}$ | $1.5 \times 10^{8}$ | $1.7 \times 10^{8}$ | – |
| | beheaded | $5.7 \times 10^{5}$ | – | $4.3 \times 10^{5}$ | $4.2 \times 10^{6}$ | – | $3.0 \times 10^{8}$ | $3.0 \times 10^{8}$ | $2.1 \times 10^{8}$ | – |
| Indian Ocean (Kantang) | *Penaeus* | | | | | | | | | |
| | whole | – | – | $2.8 \times 10^{7}$ | $5.3 \times 10^{7}$ | – | $5.4 \times 10^{7}$ | – | $1.1 \times 10^{8}$ | $2.4 \times 10^{8}$ |
| | beheaded | $1.1 \times 10^{7}$ | – | – | – | – | $4.0 \times 10^{8}$ | $7.0 \times 10^{8}$ | $1.0 \times 10^{9}$ | $7.2 \times 10^{8}$ |
| | *Penaeus* | | | | | | | | | |
| | whole | $5.3 \times 10^{4}$ | – | $3.1 \times 10^{5}$ | – | $1.7 \times 10^{7}$ | – | $6.0 \times 10^{7}$ | – | – |
| | whole | $5.3 \times 10^{4}$ | – | $3.1 \times 10^{5}$ | – | $9.6 \times 10^{6}$ | – | $3.0 \times 10^{7}$ | – | – |
| Gulf of Thailand (Cholburi) | *Metapenaeus* | | | | | | | | | |
| | whole | $6.7 \times 10^{4}$ | $3.4 \times 10^{4}$ | $9.0 \times 10^{5}$ | $1.5 \times 10^{6}$ | – | $6.5 \times 10^{7}$ | – | – | – |
| | beheaded | $5.8 \times 10^{4}$ | $6.6 \times 10^{4}$ | $8.2 \times 10^{4}$ | $2.2 \times 10^{5}$ | – | $2.2 \times 10^{5}$ | – | – | – |
| Gulf of Thailand (Samudh Sakorn) | *Penaeus* | | | | | | | | | |
| | whole | $3.0 \times 10^{4}$ | $4.3 \times 10^{4}$ | $7.7 \times 10^{4}$ | $4.0 \times 10^{4}$ | – | $9.9 \times 10^{6}$ | $2.5 \times 10^{7}$ | – | – |
| | beheaded | $3.7 \times 10^{4}$ | $7.2 \times 10^{4}$ | $7.9 \times 10^{4}$ | $1.9 \times 10^{6}$ | – | $5.6 \times 10^{6}$ | $1.5 \times 10^{8}$ | – | – |
| Mozambique | *Penaeus* | | | | | | | | | |
| | whole | $5.1 \times 10^{4}$ | – | – | – | – | $1.6 \times 10^{7}$<br>$1.9 \times 10^{7}$<br>$1.6 \times 10^{7}$ | – | – | – |
| Malaysia | *Penaeus* | | | | | | | | | |
| | beheaded | $8.3 \times 10^{6}$ | – | – | – | – | $2.0 \times 10^{8}$<br>$2.0 \times 10^{8}$<br>$1.8 \times 10^{8}$ | – | – | – |

Source: Cann, 1974a

TABLE 7. *Total viable counts (organisms/g, at 35°C) of shrimp stored in ice*

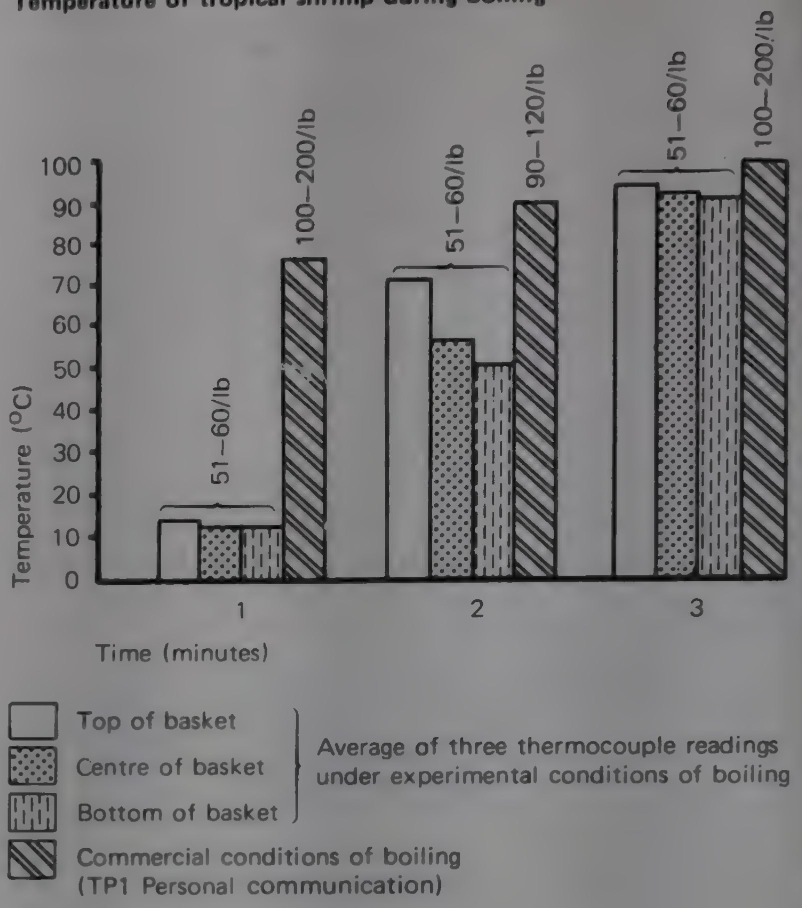
| *Fishing area (Port of landing)* | *Genus* | *Days' storage* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 5–6 | 8–9 | 10 | 12 | 14 | 16 | 18 |
| Gulf of Thailand (Songkhla) | *Penaeus* | | | | | | | | | |
| | whole | $>10^3$ | – | $1.3 \times 10^5$ | $1.9 \times 10^4$ | – | $4.5 \times 10^4$ | $4.4 \times 10^5$ | $7.0 \times 10^5$ | – |
| | beheaded | $2.3 \times 10^3$ | – | $1.5 \times 10^5$ | $1.4 \times 10^4$ | – | $2.9 \times 10^4$ | $1.7 \times 10^6$ | $3.0 \times 10^5$ | – |
| Indian Ocean (Kantang) | *Penaeus* | | | | | | | | | |
| | whole | – | – | $3.4 \times 10^6$ | $4.0 \times 10^6$ | – | $1.1 \times 10^7$ | – | $2.9 \times 10^5$ | $5.4 \times 10^5$ |
| | beheaded | $9.6 \times 10^6$ | – | – | $2.5 \times 10^5$ | – | $2.6 \times 10^5$ | $5.6 \times 10^5$ | $3.5 \times 10^5$ | $1.4 \times 10^5$ |
| | *Penaeus* | | | | | | | | | |
| | whole | $3.2 \times 10^3$ | – | $1.1 \times 10^4$ | – | $1.9 \times 10^4$ | – | $4.6 \times 10^4$ | – | – |
| | whole | $2.1 \times 10^3$ | – | $1.1 \times 10^4$ | – | $7.9 \times 10^3$ | – | $2.3 \times 10^4$ | – | – |
| Gulf of Thailand (Cholburi) | *Metapenaeus* | | | | | | | | | |
| | whole | $5.7 \times 10^4$ | $1.4 \times 10^6$ | $3.8 \times 10^4$ | $2.0 \times 10^4$ | – | $9.3 \times 10^5$ | – | – | – |
| | beheaded | $3.6 \times 10^4$ | $2.6 \times 10^4$ | $3.6 \times 10^4$ | $2.1 \times 10^4$ | – | $3.1 \times 10^4$ | – | – | – |
| Gulf of Thailand (Samudh Sakorn) | *Penaeus* | | | | | | | | | |
| | whole | $2.4 \times 10^4$ | $2.5 \times 10^4$ | $1.7 \times 10^5$ | $6.8 \times 10^4$ | – | $1.2 \times 10^5$ | $4.9 \times 10^6$ | – | – |
| | beheaded | $2.2 \times 10^4$ | $4.3 \times 10^4$ | $2.4 \times 10^4$ | $4.1 \times 10^4$ | – | $3.1 \times 10^4$ | $7.8 \times 10^5$ | – | – |
| Mozambique | *Penaeus* | | | | | | | | | |
| | whole | $6.3 \times 10^4$ | – | – | – | – | $2.7 \times 10^5$ | – | – | – |
| Malaysia | *Penaeus* | | | | | | | | | |
| | beheaded | $3.0 \times 10^6$ | – | – | – | – | $2.9 \times 10^7$ | – | – | – |

Source: Cann, 1974a

The effect of ice is variable; it is essential for the control of bacterial growth but may, if poorly prepared, be the source of heavy contamination (Iyer *et al.*, 1971).

Figure 1

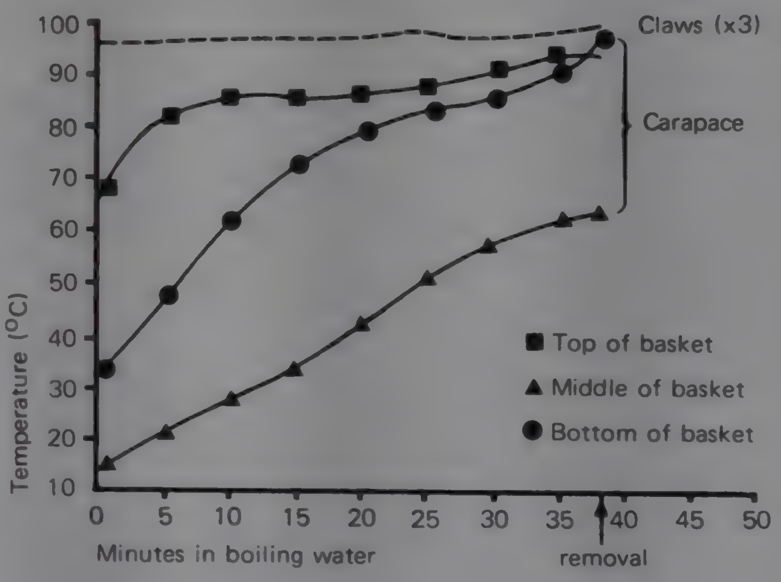
Temperature of tropical shrimp during boiling



The value of beheading crustaceans is debatable. On the one hand there are numerous reports in the literature (mainly the results of work on penaeid shrimp caught in the Gulf of Mexico) stating the benefit of removal of the heads of crustaceans; Williams *et al.* (1952b) reported that beheading of shrimp reduced counts by 50–60%. Similar figures were given by Novak (1973) who found that although the head of shrimp constitutes 40% of the body weight it contains about 75% of the bacterial load. On the other hand studies on tropical shrimp in Thailand (Tables 6 and 7) and further studies in the USA (Bieler *et al.*, 1972; Koburger *et al.*, 1973) showed no significant differences in bacterial counts in the body meats whether they were stored whole or beheaded. Moreover these findings were indirectly supported by chemical and organoleptic assessment. There are good economic reasons for the beheading of crustaceans at time of catching but these are other than bacteriological. Of major importance is the prevention of black spot, an enzymic reaction which develops initially on the head of crustaceans and spoils the appearance and sales value of catches.

Figure 2

Temperature of crabs during boiling process



## Heat treatment

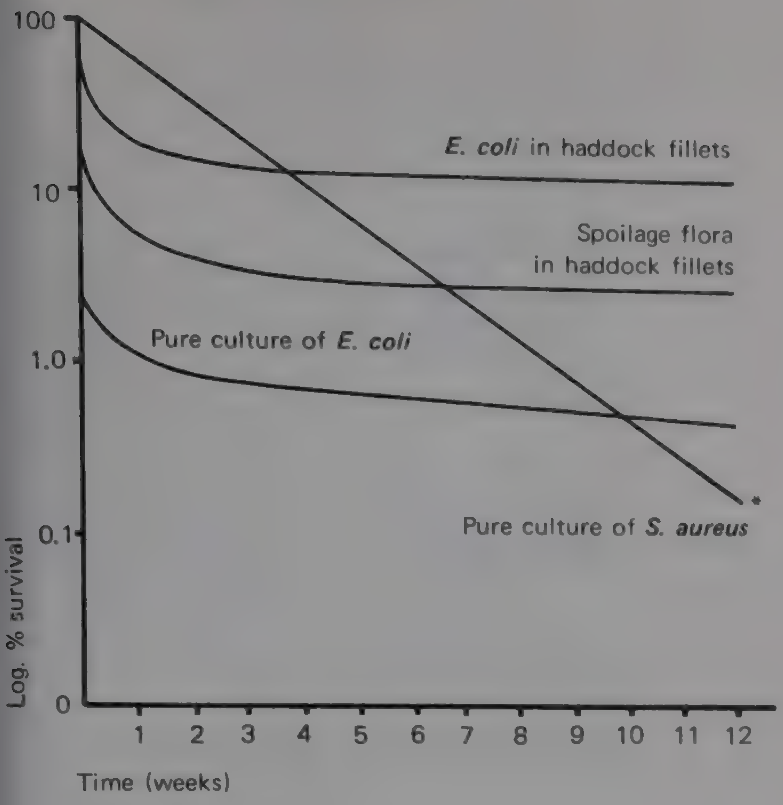
Heat kills bacteria and destroys their preformed toxins. Its effect however is dependent on time and temperature. Apart from canning, which is a specialized process outside the scope of this paper, heat treatments of shellfish usually vary from scalding, which merely opens the shells of molluscs, to full cooking, by boiling or either free or low pressure steaming.

Scalding treatments have little effect on the bacterial content of body meats of shellfish. Cooking reduces the bacterial numbers present but is unlikely to produce a sterile product except in the case of very small specimens. Commerical cooking times have often been devised on a trial and error basis with the sole purpose of obtaining the best yield and flavour on the general assumption that sterility also occurred. In the case of gastropod molluscs this appears to be true. Cooking times necessary for the easy removal of the body meats usually achieve this objective (Reynolds, 1957). However findings with other shellfish present a different picture. In order to lower the counts to acceptable working levels, considerable modification of cooking times may be necessary as shown in studies of commercial boiling methods (Figures 1 and 2). Since a time/temperature combination of 65°C for up to 30 minutes may be required to kill all vegetative forms of food-poisoning bacteria it is obvious that commerical cooking practices may be insufficient. Although Pilsworth (1952) showed that steaming times of 6 minutes sterilized cockles and mussels, studies on commerical processing of crustaceans have shown that counts at 37°C on temperate crab can be as high $3.7 \times 10^5$/g after boiling for 30 minutes, and $4.5 \times 10^4$/g on tropical prawns after boiling for 3 minutes. In view of these findings, a compromise may well be necessary between the optimum cooking time required for eating, the weight loss and bacteriological quality.

Freezing below –5°C arrests bacterial growth and at lower temperatures 60–90% of the population may be killed; gram-positive bacteria surviving better than gram-negative bacteria (Figure 3). Subsequent cold storage usually results in a further slow fall in the number of survivors. Amongst the food-poisoning bacteria, *V. parahaemolyticus* is widely reported to be particularly sensitive to freezing. However, Johnson and Liston (1973), after reviewing the available data and on the basis of their own studies, concluded that, although the organism was sensitive, cold storage alone would not eliminate the organism from seafoods. Furthermore, the

**Figure 3**

**Effect of freezing on bacterial counts**



*Source: Iyer, 1971

**Figure 4**

**Total viable counts on temperate shrimp during processing**

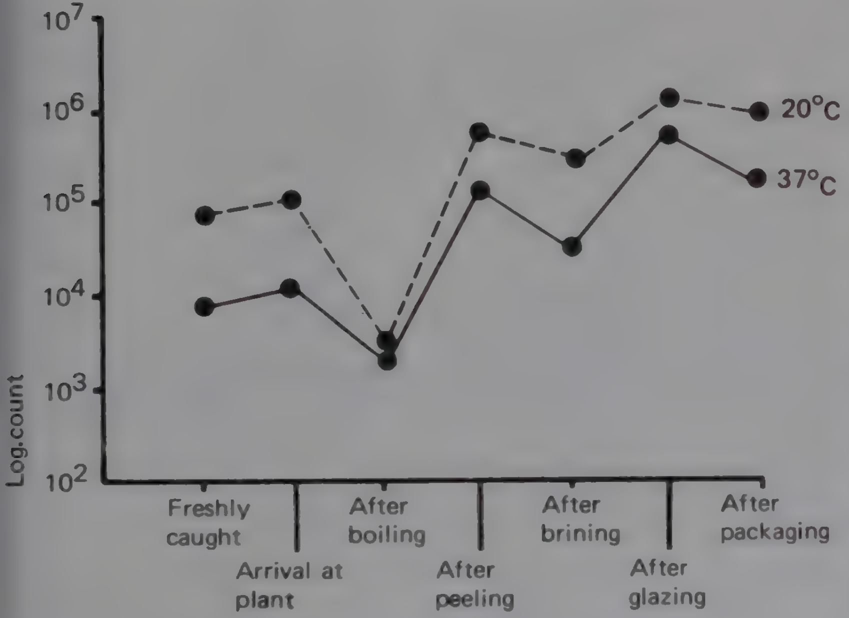


**Figure 5**

**Standard plate counts on tropical prawns during commercial processing of the raw, peeled product**

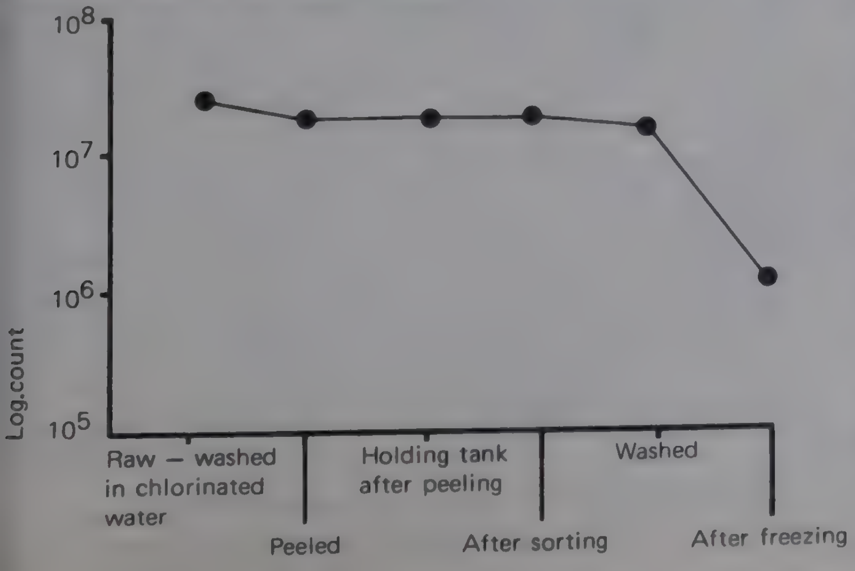
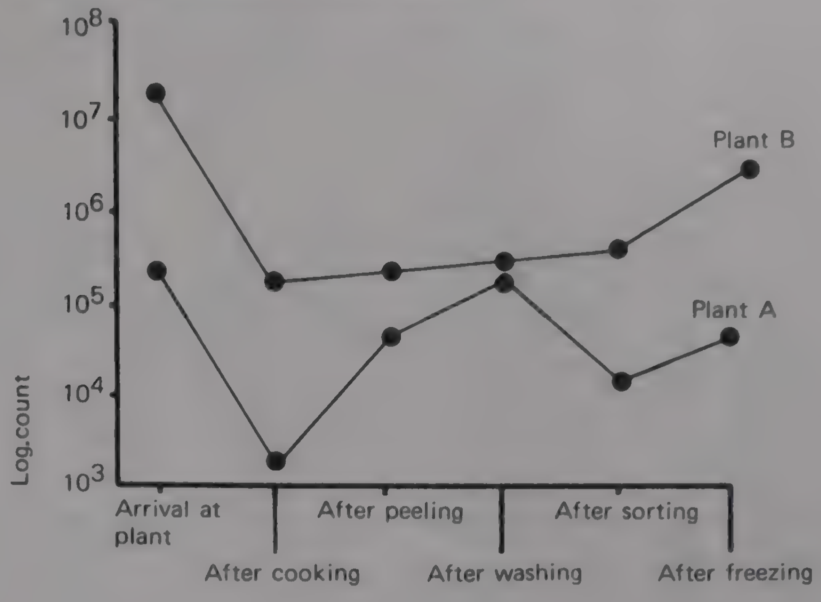


**Figure 6**

**Standard plate counts on tropical prawns during commercial processing of the cooked, peeled product**



isolation of *V. parahaemolyticus* from tropical prawns which had been in cold storage alone would not eliminate the organism from seafoods. Furthermore, the isolation of *V. parahaemolyticus* from tropical prawns which had been in cold storage at –20°C for 13 months (Cann and Taylor, unpublished results), implies either greater resistance to freezing by *V. parahaemolyticus* than previously reported or massive contamination of this particular batch of prawns.

In the variety of treatments that shellfish undergo during processing, the bacterial numbers fluctuate and what is more important the composition of the flora may alter. Figure 4 shows the effect of processing on total viable counts on *Pandalus* shrimp. Figures 5 and 6 show the effect of processing on counts on raw and cooked tropical shrimp respectively. In general, counts varied no more than tenfold from start to finish of processing. These results are typical of commercial practice whether in the tropics or not (Tables 8, 9 and 10). What can be achieved in terms of the total viable count is therefore very dependent on the initial counts on shellfish. Where experience shows that shellfish from certain areas carry high bacterial loads, the processor may have to introduce either pasteurization of packaged products or a terminal second cooking to meet bacteriological requirements.

## Bacteriological quality control

Bacteriological testing of products is now well recognized as an integral part of quality control procedures in food industries throughout the world. To be truly effective, it needs to commence with the raw materials used in food manufacture and continue through succeeding stages of processing and transport until it reaches the consumer. The particular relevance of microbiological quality control to the shellfish industry was discussed in detail by Hobbs (1970).

Prior to the development of freezing, bacteriological testing of fishery products was largely retrospective. Analysis takes considerable time and, in the past, such

TABLE 8. *Bacteriological examination of factory processed raw shellfish in Thailand*

| Processor | Type | *Coliforms* | *Faecal coli* | *Faecal streptococci* | *Bacterial count* | |
|---|---|---|---|---|---|---|
| | | *Most probable numbers/g (MPN/g)* | | | *Organisms/g at 20°C* | *Organisms/g at 35°C* |
| A | Flower shrimp | | | | | |
| | before processing | 72 | 2 | 6.4 | $5.1 \times 10^6$ | $6.6 \times 10^5$ |
| | frozen packaged | 168 | 168 | 149.3 | $8.2 \times 10^6$ | $3.9 \times 10^7$ |
| | White shrimp | | | | | |
| | before processing | 144 | 0.9 | 44 | $1.0 \times 10^6$ | $2.5 \times 10^6$ |
| | frozen packaged | 152 | 152 | 46.4 | $5.5 \times 10^6$ | $1.5 \times 10^7$ |
| B | White shrimp | | | | | |
| | before processing | 40.4 | 2.8 | 9.7 | $4.7 \times 10^5$ | $9.8 \times 10^5$ |
| | frozen packaged | $>123$ | 29 | 30.7 | – | $1.2 \times 10^6$ |
| | Pink shrimp | | | | | |
| | before processing | 12.9 | 1.1 | 34.9 | – | $2.4 \times 10^5$ |
| | frozen packaged | 122.4 | 122.4 | 61.2 | – | $1.3 \times 10^6$ |
| C | Flower shrimp | | | | | |
| | before processing | 96 | 0.8 | 0.8 | $4.7 \times 10^6$ | $1.4 \times 10^5$ |
| | frozen packaged | 27 | 0.6 | 113 | $3.9 \times 10^6$ | $6.7 \times 10^5$ |
| | White shrimp | | | | | |
| | before processing | 114 | 96 | 101 | $6.5 \times 10^6$ | $4.6 \times 10^6$ |
| | frozen packaged | 31.2 | 2.5 | 19.1 | $3.3 \times 10^6$ | $4.0 \times 10^5$ |
| | Cuttlefish | | | | | |
| | before processing | 12.8 | 0.4 | 0.7 | $1.6 \times 10^5$ | $4.4 \times 10^4$ |
| | frozen packaged | 5.7 | 0.6 | 88 | $1.0 \times 10^6$ | $3.0 \times 10^3$ |
| D | White shrimp | | | | | |
| | before processing | 33 | 4.8 | 108 | $1.1 \times 10^6$ | $3.9 \times 10^5$ |
| | frozen packaged | 15 | 4.2 | 0.5 | – | $7.6 \times 10^5$ |
| | Pink shrimp | | | | | |
| | before processing | 84 | 0.12 | 1.5 | $1.1 \times 10^6$ | $2.3 \times 10^5$ |
| | frozen packaged | 21 | 3.0 | 33 | – | $3.1 \times 10^5$ |
| | Cuttlefish | | | | | |
| | before processing | $>108$ | $>105$ | $>108$ | $3.8 \times 10^6$ | $4.0 \times 10^5$ |
| | frozen packaged | $>108$ | $>108$ | $>108$ | – | $3.4 \times 10^6$ |
| E | Flower shrimp | | | | | |
| | before processing | 130 | 50.8 | 116 | $1.7 \times 10^7$ | $5.0 \times 10^6$ |
| | frozen packaged | 144 | 128 | 128 | $3.8 \times 10^7$ | $5.9 \times 10^6$ |
| | Pink shrimp | | | | | |
| | before processing | 144 | 3.6 | 72 | $1.8 \times 10^6$ | $8.6 \times 10^5$ |
| | frozen packaged | 142 | 43 | 23.6 | $8.3 \times 10^6$ | $1.3 \times 10^6$ |

Source: Cann, 1974a

TABLE 9. *Bacteriological examination of factory processed shrimp in Malaysia*

| *Processor* | *Type* | *Coliforms present in* | | *Faecal coli present in* | | *Standard plate count* |
|---|---|---|---|---|---|---|
| | | *0.1g* | *0.01g* | *0.1g* | *0.01g* | *(Organisms/g)* |
| A | Cooked, peeled | | | | | |
| | before processing | NT | | NT | | $3.8 \times 10^6$ |
| | frozen packaged | | | | | $5.6 \times 10^4$ |
| | before processing | NT | | NT | | $6.1 \times 10^6$ |
| | frozen packaged | | | | | $2.9 \times 10^5$ |
| | before processing | NT | | NT | | $1.5 \times 10^6$ |
| | frozen packaged | | | | | $6.5 \times 10^4$ |
| | before processing | + | – | + | – | $3.8 \times 10^5$ |
| | frozen, packaged | + | – | – | – | $6.5 \times 10^4$ |
| B | Cooked, peeled | | | | | |
| | before processing | + | + | + | + | $2.9 \times 10^7$ |
| | frozen packaged | + | – | – | – | $4.0 \times 10^6$ |
| C | Raw, peeled | | | | | |
| | before processing | + | + | + | – | $4.9 \times 10^7$ |
| | frozen packaged | + | – | – | – | $1.0 \times 10^6$ |

Source: TPI, personnal communication
NT – not tested

TABLE 10. *Bacteriology of frozen packaged temperate shellfish*

| *Type* | *Total viable counts at 37°C/g* | | *Faecal coliforms MPN/g* | |
|---|---|---|---|---|
| | *Range* | *>$10^6$/g* | *Range* | *>4/g* |
| Cooked | | | | |
| Crab white meat | $2.4 \times 10^5$–$6.1 \times 10^5$ | 0/5 | 0–1.3 | 0/5 |
| brown meat | $3.9 \times 10^4$–$3.2 \times 10^5$ | 0/5 | 0–>90 | 1/5 |
| Shrimp | $5.3 \times 10^3$–$2.7 \times 10^5$ | 0/23 | 0–0.1 | 0/23 |
| Raw | | | | |
| Scallops | $2.2 \times 10^3$–>$1.5 \times 10^7$ | 5/14 | 0–0.3 | 0/14 |
| Queens | $2.2 \times 10^4$–$1.8 \times 10^7$ | 22/37 | 0–>72 | 2/37 |
| Scampi* | $3.8 \times 10^5$–$2.3 \times 10^7$ | 11/16 | 0–>72 | 4/13 |

**Staphylococcus aureus* countable in one sample at 400/g (Hobbs *et al.*, 1971)

highly perishable products as shellfish were rapidly distributed and beyond recall before the bacteriological quality was known. Nevertheless routine testing (of raw materials, shellfish on the production line, and the sanitary quality of water supplies and processing equipment) did establish a norm for good manufacturing practice and indicated when standards were falling. Today, international trade in shellfish is mostly in either frozen or canned products which are relatively stable and can be held until the results of analysis are available. Consequently, processors can now grade their products and choose their markets according to the requirements of foreign importers. Where products are of unacceptable quality they can be either re-processed or put to alternative use, thus eliminating the unethical and costly procedure of touting shipments from port to port in the hope of eventual acceptance by a less vigilant port health authority (Semple, 1960).

The indices used in quality control vary and may comprise one or more of the following groups:

1. Total viable counts: usually required in the form of the Standard Plate Count (SPC) at 35°C but may be desired as aerobic surface counts at 20, 25, 30 or 37°C.
2. Counts of organisms of public health significance: this group comprises coliforms, faecal coliforms (*E. coli*), faecal streptococci (enterococci), Enterobacteriaceae and total clostridia.
3. Counts of potential food-poisoning bacteria: *Staphylococcus aureus, Clostridium perfringens (welchii), Vibrio parahaemolyticus* and *Bacillus cereus.*
4. Absence of food-borne pathogens: *Salmonella, Vibrio cholera (comma)* and *Clostridium botulinum.*

The indices used most in international trade are shown in Table 11 in the form of commerical standards which are still commonly applied to temperate and tropical shellfish.

TABLE 11. *Typical bacteriological standards applied to shellfish*

| | *Temperate* | *Tropical* |
|---|---|---|
| Standard plate count | $<10^5$/g | $<10^5$/g |
| *Escherichia coli* (MPN) | nil/g | nil/g |
| *Staphylococcus aureus* | nil/g | nil/g |
| Enterococci | – | – |
| *Vibrio cholera* | – | nil/g |

The value of total bacterial counts as indices of spoilage in quality control of shellfish is doubtful. Whereas there is always a rise in counts at 20°C during spoilage, their interpretation is difficult as numbers vary considerably among different samples. Counts at 20°C are mainly of use in the evaluation of new or alternative refrigerating techniques for preservation of fishery products. In this context, there appears to be considerable potential for the storage of tropical shrimp using chilled seawater injected with carbon dioxide. Counts at 35–37°C do not vary systematically during spoilage of shellfish in ice, usually fluctuating about one log. number of the initial value (Tables 5 and 6). Their worth lies, therefore, more as indicators of contamination and associated health hazards that result from insanitary handling and processing.

A more specific indicator of potential hazards to health are faecal coliforms. In waters and in live shellfish, they are used to monitor the degree of sewage pollution that may have occurred along with the concomitant risk of contamination by salmonellae (Table 12). This type of monitoring is usually restricted to bivalve molluscs which are marketed raw in the shell, when special measures of depuration are required (Ayres 1975b). The presence of faecal coliforms during processing indicates faecal contamination of food and equipment resulting from unhygienic handling.

Control measures must take into account the source of each consignment of shellfish and the probable bacteriological quality. In both temperate and tropical zones, catches of shellfish from deeper waters can be expected to be relatively free from *Salmonella, Cl. perfrigens* and *V. parahaemolyticus;* assuming the practice of adequate hygiene, these organisms should present few problems. Shellfish caught or harvested from inshore and estuarine waters may present specific problems concerning *Salmonella,* total viable counts and, especially in the tropics, *V. parahaemolyticus.* In addition to its high incidence in certain areas, *V. parahaemolyticus* grows very rapidly at ambient temperatures in the tropics. Fortunately, its sensitivity to cooking and freezing provides effective means of quality control. *Cl. botulinum* and *Bacillus cereus* do not present particular problems at present. However, any changes in the pattern of ultilization of shellfish by development of lightly smoked, salted or western-type convenience foods must take these organisms into account. *Bacillus cereus,* for example, is known to be a heavy contaminant of rice and has been the cause of food poisoning in people eating mixed rice and shellfish dishes (Gilbert *et al.,* 1974).

Along with high total viable counts, the presence of *S. aureus* is probably the main cause of rejection of tropical shellfish by importing health authorities. *Staphylococcus aureus* competes poorly against the natural flora of many foodstuffs but appears to have a predilection for crustacean shellfish since, once they are cooked, it can become a major contaminant. Furthermore, the high numbers of *S. aureus* which have been found in cooked tropical shrimp indicate the organism's ability to grow rapidly in crustaceans under tropical conditions of processing (Table 13). *S. aureus* is a common commensal of the nose, mouth, hands and hair, as well as the cause of skin lesions; its control is essentially the creation of a high standard of personal hygiene amongst processing personnel along with stringent control of the temperature of shellfish at all stages of processing.

## Bacteriological standards

Legal bacteriological standards for shellfish are not, as yet, common but commercial standards are now widely applied. Development of export markets increasingly depends on the ability of an industry to meet the requirements of local and importing health authorities. These may vary from mere certificates of health to compliance with a number of bacteriological limits. Dick (1970) reviewed the arguments for and against the application of microbiological standards for foods. Where standards are applied there are serious disadvantages in the application of too severe and too rigid limits on the principle of making foods 'safer than safe' (Cann, 1974a; Bindloss, 1975)

In successive publications, workers at Torry have stated that, in their opinion, limits or standards of the type shown in Table 11 are too severe; particularly as they embrace all products whether or not they are cooked, shelled, de-veined or frozen (Hobbs *et al.,* 1971; Cann, 1974a and b). Fortunately the situation, at least for crustaceans, has been rationalized by the presentation of recommended limits by the International Commission on Microbiological Specifications for Food of the International Association of Microbiological Societies (ICMSF 1974). These limits (Table 14) were derived after evaluation of relative health hazards resulting from different products and from what can be achieved by good commercial and manufacturing practice. In formulating the limits, the ICMSF have recognized processing difficulties in allowing tolerances for samples that may exceed an 'ideal limit'.

TABLE 12. *Comparison of bacterial standards for shellfish (expressed as numbers/100g or/100 cm$^3$ of tissue)*

| *Quality* | | *British Standard (Numbers of* E. coli*/100 cm$^3$ by roll tube)* | | *French Standard (Numbers of* E. coli*/100 cm$^3$ of phenol broth)* | *US Standard (Numbers of faecal coliforms/100g by MPN techniques)* |
|---|---|---|---|---|---|
| | *Grade* | *Sherwood and Scott Thomson (1953)* | *Class* | *Boury (1962)* | *Kelly (1964)* |
| Acceptable | I | Up to 500 | I | Less than 100 | Up to 230 |
| | | | II | Between 100 and less than 500 | NA |
| Suspicious | II | Greater than 500 not more than 1500 | III | Between 500 and less than 1500 | NA |
| Unacceptable | III | More than 1500 | IV | 1500 or more | Greater than 230 |

Source: Ayres (1975)
NA: Not applicable

TABLE 13. *Bacteriological analysis of imported frozen, cooked, tropical prawns (London, December 1974)*

| *Shipment* | *Standard plate count* | | *Coliforms* | *Faecal coli* | Staphylococcus aureus | |
|---|---|---|---|---|---|---|
| | *Organisms/g** | $>10^6/g$ | *Presence in 0.1g* | | *Organisms/g** | $>10^3/g$ |
| A | $3.2 \times 10^4$ | 0/5 | Nil | Nil | 61 | 0/5 |
| B | $1.5 \times 10^6$ | 4/5 | 4/5 | Nil | 1,400 | 3/5 |
| C | $1.6 \times 10^6$ | 3/5 | Nil | 1/5 | 19,000 | 5/5 |
| D | $2.3 \times 10^6$ | 4/5 | 3/5 | Nil | 1,600 | 1/5 |
| E | $5.2 \times 10^5$ | 0/5 | 3/5 | Nil | 490 | 0/5 |
| F | $1.3 \times 10^6$ | 3/5 | 2/5 | Nil | 540 | 1/5 |
| G | $3.0 \times 10^4$ | 0/5 | 1/5 | Nil | <50 | 0/5 |
| H | $1.4 \times 10^6$ | 4/5 | 1/5 | 1/5 | 2,320 | 4/5 |
| I | $1.7 \times 10^6$ | 3/5 | 2/5 | 2/5 | 3,400 | 3/5 |

*Average of five analyses

TABLE 14. *Recommended bacteriological limits for shellfish products*

| *Product* | *Test* | *Sample number to be examined* | *Tolerance between m-M* | *Limit per g* | |
|---|---|---|---|---|---|
| | | | | *m* | *M* |
| Frozen, raw shrimp, prawns and lobster tails | SPC [1,2] | 5 | 3 | $10^6$ | $10^7$ |
| | Faecal coliforms (MPN) | 5 | 3 | 4 | 400 |
| | *Staphylococcus* | 5 | 3 | $10^3$ | $2 \times 10^3$ |
| | *V. parahaemolyticus* | 5 | 0 | $10^2$ | – |
| Frozen, cooked shrimp, prawns and obster tails | SPC [1,2] | 5 | 1 | $10^6$ | $10^7$ |
| | Faecal coliforms (MPN) | 5 | 1 | 4 | 400 |
| | *Staphylococcus* (path)[3] | 5 | 1 | $10^3$ | $2 \times 10^3$ |
| | *V. parahaemolyticus*[4] | 5 | 0 | $10^2$ | – |
| Frozen, raw breaded shrimp and prawns | SPC [1,2] | 5 | 3 | $10^6$ | $10^7$ |
| | Faecal coliforms (MPN) | 5 | 3 | 4 | 400 |
| | *Staphylococcus* (ind)[3] | 5 | 3 | $10^3$ | $2 \times 10^3$ |
| | *V. parahaemolyticus*[4] | 5 | 0 | $10^2$ | – |
| Cooked, picked crabmeat | SPC [1,2] | 5 | 3 | $10^5$ | $10^6$ |
| | Faecal coliforms (MPN) | 5 | 3 | 4 | 400 |
| | *Staphylococcus* (path)[3] | 5 | 3 | $10^3$ | $2 \times 10^3$ |
| | *V. parahaemolyticus*[4] | 5 | 0 | $10^2$ | – |

Notes: 1. Incubation temperature for frozen products should be 25°C; cooked products 35°C.
2. Average SPC for shrimps in normal international trade are very high and SPC is of doubtful significance.
3. (ind) refers to *Staphylococcus* as indicator; (path) as a toxinogenic pathogen.
4. Testing for *V. parahaemolyticus* is recommended only for products from areas of high incidence (eg SE Asia and Japan) and hazardous products harvested during warm weather periods in other areas.
m Acceptable level.
M Marginally acceptable level. Values at or above M are unacceptable.

There is, however, one anomaly in the proposed limits and that is the lower limit set for cooked crabmeats in comparison with cooked shrimp. Both these types of product have, from time to time, been similarly incriminated in food-poisoning outbreaks, furthermore, the production of picked crabmeat is technically more difficult than that of peeled shrimp.

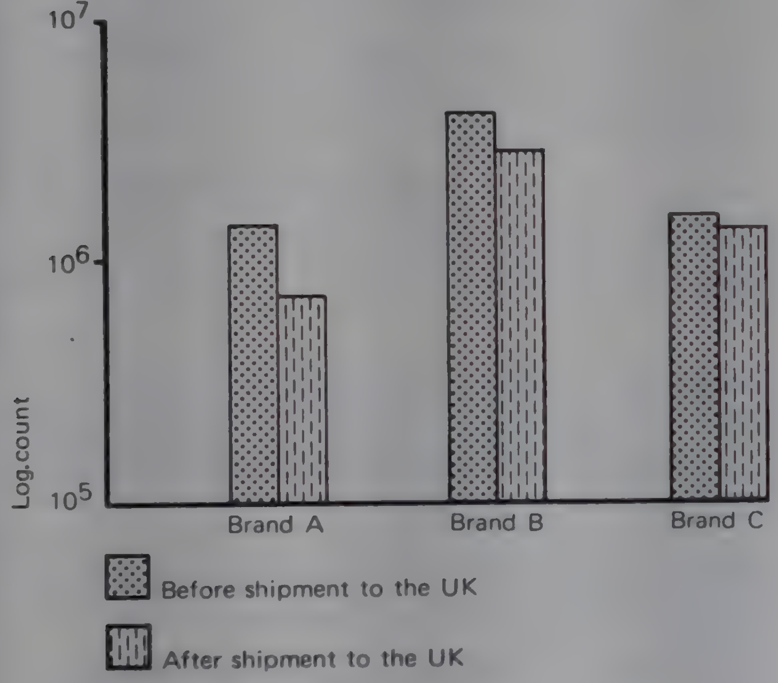
Examination of Tables 8, 9 and 10 shows that the ICMSF limits can be met by both tropical and non-tropical crustacean products although certain tropical types may still present difficulties. Table 13 illustrates this point. Imported prawns examined at the Port of London showed that six of nine shipments would have been rejected. On the other hand examination of tropical shrimp imported into Japan from S America, W Africa, SE Asia and Oceania showed that only one of 22 shipments would have failed the recommended limits (Kawabata *et al.*, 1975).

The application of limits or standards to other shellfish still needs to be rationalized. There appears to be no good reason why deep-water cephalopods and molluscs, which in any case are cooked before eating, should not be included in the ICMSF limits. Standards, for presence of *E. coli*, which are specifically applied to raw bivalve molluscs are shown in Table 12. In addition to the requirements for *E. coli,* US regulations stipulate a plate count of $10^5$/g for consignments to be accepted without question. It is, perhaps, worthy of note that products with a past history of serious incrimination in outbreaks of enteric fever, cholera and heptatitis (and consequently the cause of public mistrust of all shellfish) often have to meet *less* stringent bacteriological requirements than those which are cooked before eating.

## The role of government agencies in a shellfish exporting industry

Some involvement by government agencies is inevitable in a viable and stable shellfish exporting industry. The areas in which government agencies require to be active is aptly illustrated by the development of the Indian industry (Mathen, 1974). To export, processors require letters of credit and insurance cover and to obtain these they usually require health certificates, which can only be issued impartially by a non-profit making government agency. Where government laboratories are unable to cope with the volume of bacteriological work incurred, only accredited private laboratories must be used. The sampling and analytical methods used by these laboratories must be internationally acceptable (Thatcher and Clark, 1968) and the accuracy of their work regularly checked. Reliable analysis is essential if frequent disputes between exporters and importers are to be avoided. For example, Figure 7 shows that total counts of prawns did not rise during shipment from the Far East to the UK yet this work was necessary to convince one Association of Shellfish Exporters that a 'super psychrophile' was not active in their products and an apparent regular rise of 2 to 3 log. numbers was due to no other cause than faulty analyses before shipment (Taylor and Cann, unpublished results; TPI, personal communication).

**Figure 7**
**Standard plate counts of Malaysian frozen prawns**



### References

**Alford, J. A. Tobin, L. & McCleskey, C. S.** (1942) *Food Res.*, **7**, 353.

**Ayres, P.** (1975a) The quantitative bacteriology of some commerical bivalve shellfish entering British markets. *J. Hyg.*, **74** (3), 431–440.

**Ayres, P.** (1975b) FAO FIR/TPLR/75:2/28, 23pp.

**Barrow, G. I.** (1973) Marine micro-organisms and food poisoning. In: *The microbiological safety of food* (eds B. C. Hobbs & J. H. B. Christian), p.181. London: Academic Press, 487pp.

**Barrow, G. I.** (1974) *Postgrad. Med. J.*, **50**, 597.

**Bieler, A. C., Matthews, R. F. & Koburger, J. A.** (1972) In: *Proc. 25th Session of the Gulf and Caribbean Fisheries Institute*, p.56.

**Bindloss, A. A.** (1975) Current trends in international feed standards. In: *Proc. Conf. on animal feeds of tropical and subtropical origin.* London, 1–5 April 1975, pp.221–225. London: Tropical Products Institute, 340pp.

**Cann, D. C.** (1971) Report to the Government of Thailand on fish handling and processing. Rep. FAO/UNDP (TA), (3021). Rome: FAO, 17pp.

**Cann, D. C.** (1974a) Bacteriological aspects of tropical shrimp. In: *Fishery products* (ed. R. Kreuzer), pp. 338–344. Surrey: Fishing News Books, 462pp.

**Cann, D. C.** (1974b) In: *Proc. 5th Annu. Conf. Shellfish Association of Britain*, p.14.

**Cann, D. C., Hobbs, G., Wilson, B. B. & Horsley, R. W.** (1971) The bacteriology of scampi (*Nephrops norvegicus*). II. Detailed investigation of the bacterial flora of freshly caught samples. *J. Food Technol.*, **6**, 153–161.

**Carroll, B. J., Garrett, E. S., Reese, G. B. & Ward, B. Q.** (1966). Presence of *Clostridium botulinum* in the Gulf of Venezuela and the Gulf of Darién. *Appl. Microbiol.*, **14** (5), 837–838.

**Castell, C. H.** (1973) Microbiological considerations in the handling of raw fish. In: *Microbial safety of fishery products* (eds. C. O. Chichester & H. D. Graham), pp. 75–84. New York: Academic Press, 334pp.

**Dick, M. I. B.** (1970) Microbial standards for foods. *Food Technol. Australia*, **22** (9), 508.

**Early, J. C.** (1967) M. Sc. Thesis, University of Nottingham.

**FAO/WHO** (1969) Recommended international code of practice. General principles of food hygiene CAC/RCP 1–1969. Rome: FAO.

**FAO** (1975a) Code of practice for shrimp or prawns. *FAO Fish. Circ.* No. C322. Rome: FAO, 41pp.

**FAO** (1975b) Code of practice for lobsters and related species. *FAO Fish. Circ.* No. C330. Rome: FAO.

**Fieger, E. A.** (1950) Problems in handling fresh and frozen shrimp. *Food Technol., Champaign*, **4**, 409.

**Fieger, E. A., Bailey, M. E. & Novak, A. F.** (1956) Chemical ices for shrimp preservation. *Food Technol., Champaign*, **10**, 578.

**Gilbert, R. J., Stringer, M. F. & Peace, T. C.** (1974) The survival and growth of *Bacillus cereus* in boiled and fried rice in relation to outbreaks of food poisoning. *J. Hyg.*, **73** (3), 433–444.

**Green, M.** (1949a) Bacteriology of shrimp. II Quantitative studies on freshly caught iced shrimp. *Food Res.*, **14**, 372.

**Green, M.** (1949b) *Food Res.*, **14**, 384.

**Harris, M. M.** (1932) *Am. J. Hyg.*, **15**, 260.

**Hobbs, G.** (1970) Microbial quality control. Proc. Conf. on Canadian shrimp fishery, St John, New Brunswick, 27–29 October 1970. *Can. Fish Rep.* 17.

**Hobbs, G** (1976) *Clostridium botulinum* and its importance in fishery products. In: *Advances in food research* (eds. C. O. Chichester, E. M. Mrak & G. F. Stewart) Vol. 22, pp.135–185. New York: Academic Press.

**Hobbs, G., Cann, D. C., Wilson, B. B. & Horsley, R. W.** (1971) The bacteriology of scampi (*Nephrops norvegicus*). III Effects of processing. *J. Food Technol.*, **6**, 233–251.

**ICMSF** (International Commission for Microbiological Specifications for Food) (1974) *Micro-organisms in food,* **2**, 101. Toronto: University of Toronto Press.

**Iyengar, J. R., Visweswariah, K., Moorjani, M. N. & Bhatia, D. S.** (1960) Assessment of the progressive spoilage of ice-stored shrimp. *J. Fish. Res. Board Can.*, **17** (4), 475–485.

**Iyer, T. S. G., Chaudhuri, D. R. & Pillai, V. K.** (1971) Bacteriological aspects of frozen prawn products and their significance in quality evaluation. *FAO Fish. Rep.* No. 115, 59–69.

**Jacob, S. S., Iyer, K. M., Nair, M. R. & Pillai, V. K.** (1962) Quality studies on round, headless and peeled and deveined prawns held in ice storage. *Indian J. Fish.*, **9** (2), 97.

**Johnson, H. C. & Liston J.** (1973) Sensitivity of *Vibrio parahaemolyticus* to cold in oysters, fish fillets and crabmeat. *J. Food Sci.*, **38** (3), 437–441.

**Kawabata, T., Mizukami, T., Ohara, R. & Shinonara, J.** (1975) Microbiological quality of frozen shrimps imported from tropical areas. *Bull. Japan Soc. Sci. Fish.* **41** (6) 667–674.

**Koburger, J. A., Matthews, R. F. & McCullough, W. E.** (1974) Some observations on the heading of *Penaeus* shrimp. In: *Proc. 26th Session of the Gulf and Caribbean Fisheries Institute, New Orleans,* USA, 29 October 1973, pp. 144–148. (Ed. J. B. Higman) 187pp.

**Lee, J. S. & Pfeifer, D. K.** (1975) Microbial characteristics of Dungeness crab (*Cancer magistor*). *Appl. Microbiol.*, **30** (1), 72–78.

**Liston, J.** (1973) *Vibrio parahaemolyticus.* In: *Microbial safety of fishery products* (eds C. O. Chichester & H. D. Graham) pp.203–213. New York: Academic Press, 334pp.

**Mathen, C.** (1974) Quality control in the Indian fish processing industry. *Fish. Technol.*, **11** (1), 1–16.

**Mortojudo, J. W., Siagiarn, E. G., Suhadi, F., Ward, B. Q. & Ward, W. M. S.** (1973) The presence of *Clostridium botulinum* in Indonesian waters. *J. Appl. Bacteriol.*, **36**, 437–440.

**Newell, B. S.** (1973) *CSIRO Div. Fish. Oceanogr. Tech. Pap.* No. 35.

**Novak, A. F.** (1973) Microbiological considerations in the handling and processing of crustacean shellfish. In: *Microbial safety of fishery products* (eds C. O. Chichester & H. D. Graham), pp. 59–73. New York: Academic Press, 334pp.

**Pillai, V. K., Sastri, P. V. K. & Nayar, M. R.** (1961) Observations on some aspects of spoilage in fresh and frozen prawns. *Indian J. Fish.*, **8** (2), 430.

**Pilsworth, R.** (1952) *Mon. Bull. Minist. Health,* **11**, 128.

**Reynolds, N.** (1957) *Mon. Bull. Minist. Health,* **16**, 86.

**Ruello, J. N.** (1974) Handling and processing banana prawns in the Gulf of Carpentaria. *Food Technol. Aust.*, **26** (5), 186–190.

**Semple, A. B.** (1960) Some recent problems of imported food. *Med. Off.*, **104**, 101.

**Shewan, J. M.** (1977) The bacteriology of fresh and spoiling fish and the biochemical changes induced by bacterial action. In: *Proc. Conf. handl. proc. mark. trop. fish., London,* 5–9 July 1976. London: Tropical Products Institute.

**Shewan, J. M.** (1970) Bacteriological standards for fish and fishery products. *Chem. Ind.*, **6**, 193–199.

**Shewan, J. M. & Hobbs, G.** (1967) Microbiology of fish spoilage and preservation. In: *Progress in industrial microbiology,* **6**, (ed. D. J. Hochenhull) p.169. London: Iliffe Books.

**Sreenivasan, A.** (1959) A note on the bacteriology of prawns and their preservation by freezing. *J. Sci. Ind. Res.*, **18C**, 119.

**Tansaugarn, L.** (1970) The ecology of *Clostridium botulinum* type E in relation to the radiation pasteurization of fish in Thailand. *Report to the International Atomic Energy Agency, Vienna.* Research Contract No. 549/R2/RB.

**Thomson, A. B., Davis, H. K., Early, J. C. & Burt, J. R.** (1974) Spoilage and spoilage indicators in queen scallops (*Chlamys opercularis*). I. Held in ice. *J. Food. Technol.*, **9**, 381.

**Thatcher, F. S. & Clark, D. S.** (1968) *Microorganisms in foods. Their significance and methods of enumeration.* University of Toronto Press, Toronto, and Oxford University Press, Oxford, 234pp.

**Tobin, L. C. & McCleskey, C. S.** (1941) Bacteriological studies of frozen crab meat. *Food Res.*, **6**, 157.

**Venkatamaran, R., Vasavan, A. G. & Sreenivasan, A.** (1953) Preservation of semi-dried prawns. *J. Sci. Ind. Res.*, **124**, 473–474.

**Walker, P., Cann, D. & Shewan, J. M.** (1970) The bacteriology of 'Scampi' (*Nephrops norvegicus*) I. Preliminary bacteriological, chemical and sensory studies. *J. Food Technol.*, 5, 375–385.

**WHO** (1974) Fish and shellfish hygiene. *WHO Tech. Rep. Ser.* No. 550, 62pp.

**Williams, O. B., Campbell, L. L. & Rees, H. B.** (1952a) *Texas J. Sci.*, **4**, 53.

**Williams, O. B., Rees, H. B. & Campbell, L. L.** (1952b) The bacteriology of Gulf Coast shrimp. I. Experimental procedures and quantitative results. *Texas J. Sci.*, **4**, 49–52.

# Practical problems associated with the export of prawns and fishery products from tropical countries

**D. F. Townsend**
Australian Department of Agriculture, Australia

## Summary

The expansion of seafood exports from the tropics and the more recent decline are considered in relation to the quality requirements of the importing countries. The reasons for the large-scale rejections by importing countries are analysed and the effects of insurance, quality and marketing systems are considered in the light of the situation in most tropical countries.

Means of overcoming the problems in the seafood export-orientated industries in the tropics are discussed. In the past, the emphasis on quantity rather than quality led to many of the problems and it is recommended that these industries should be developed along the lines of a food industry. An orderly development of the industry is the only effective means of retaining viability and guaranteeing long-term marketing-outlets.

## Résumé

L'accroissement des exportations des produits de la mer en provenance des pays tropicaux et leur déclin plus récent sont examinés par rapport aux normes de qualité des pays importateurs. Les raisons des rejets massifs de la part des pays importateurs sont analysées et les effets des systèmes d'assurance de qualité et de commercialisation sont considérées à la lumière de la situation dans la plupart des pays tropicaux.

Les moyens de surmonter ces problèmes dans les industries se livrant á l'exportation des produits de la mer dans les pays tropicaux sont discutés. L'importance donnée dans le passé à la quantité plutôt qu'à la qualité est la cause de la plupart des problèmes et il est recommandé que le développement d'industries d'exportation de produits de la mer soit organisée comme une industrie alimentaire. Un développement organisé de l'industrie est le seul moyen efficace de conserver actifs et de garantir à long terme les possibilités commerciales.

## Resumen

Se estudia la expansión de las exportaciones de productos marinos procedentes de los trópicos y su reciente descenso en relación con los requisitos de calidad de los países importadores. Se analizan las razones de los rechazos a gran escala por los países importadores y se consideran los effectos del seguro, la calidad y los sistemas de comercialización a la luz de la situación en la mayoría de los países tropicales.

Se discuten los medios de superar los problemas de las industrias orientadas a la exportación de productos marinos en los trópicos. La mayor importancia concedida en el pasado a la cantidad más que a la calidad ha sido la causa de muchos de los problemas actuales, por lo que se recomienda que el desarrollo de las industrias de exportación de alimentos marinos se organice como una industria alimenticia. Un desarollo ordenado de la industria es el único medio efectivo de mantener la viabilidad y de garantizar las salidas comerciales a largo plazo.

## Introduction

The increase, in recent years, in the volume of seafood exports from tropical countries has been considerable; this has, however, given rise to a number of problems affecting the acceptance of these seafoods by importing countries. Any country establishing a seafood processing industry which is dependent upon the export market, should ensure that this development is organized as a food industry from its inception. Too often in the past decade, there have been examples where a country's export performance has been adversely affected by an emphasis upon quantity rather than quality. When this happens, marketing difficulties occur, a lower price for the exports is offered (even if a market remains open) and commercial goodwill will have been adversely affected.

The rejection of seafood products by importing countries has been and still is, considerable. Current records in the USA still indicate rejections due to decomposition, salmonella infection, use of unacceptable additives or preservatives, short weights, and improper or incorrect packaging and/or labelling.

These rejections represent substantial amounts of money as well as a large number of man-hours expended from catching through to processing. A feature of this area has always been the availability of insurance cover against the possibility of rejection; apart from providing a genuine cover against infrequent mishaps, the rejection cover was never designed to subsidize or encourage persistent, inefficient production. In the face of recent rejections, particularly in the USA (including frogs legs), insurance underwriters have increased premiums for rejection insurance cover and, in a number of cases, have withdrawn from this business. It is sufficient that, following the adjustment of this insurance factor, a number of export seafood producers have left the industry.

The economic climate in most of the countries which import seafood from tropical areas has, in recent times, suffered a decrease in activity. In the circumstances, it is understandable that the boom period of the sixties, when maximizing the quantity of seafood imports was the main concern, should now be replaced with a concern for quality and an interest in the orderly expansion of the producing sector of the market. The high cost of freight, interest rates, packaging etc are all combining to ensure that only first class material will be marketed in future.

Apprehension has also arisen amongst the potential seafood consumers in the developed markets of the world due to the recent publicity given to rejections and to heavy metal accumulations, such as mercury, in certain seafoods. Consumers are currently very confused and, in this confusion, seafood consumption levels per capita appear to have declined. Quite incidentally, prices of other basic foodstuffs had fallen at a time when seafood prices were, generally, still rising.

## Overcoming the problems

These varying circumstances have not assisted seafood marketing. The export seafood producer from tropical areas needs to ensure that his merchandise does not, in any way, indicate sub-standard presentation. As a guide, therefore, to assisting him in this, the following comments should be considered; they are in no way definitive but they do summarize the main areas when care should be exercised.

All seafoods are subject to rapid spoilage even under reasonable conditions; in tropical areas this spoilage is usually more rapid. Speed in handling and the maintenance of the lowest possible product temperatures are the key to success. Loss of quality begins fundamentally on the fishing vessels and this can be controlled, even on the most primitive craft, if thought is given to the problem. Ideally, ice should be carried by the vessels or, at the very least, dry containers which should shield the product from the wind, sun or rain.

An immediate problem affecting the quality of seafoods in tropical countries is the open market auction system. Naturally, the fisherman wishes to obtain the highest possible price for his catch but, all too often in a market or auction system, the processor will delay bidding for the product thus hoping to lower the price. This delayed bargaining effect, plus the double handling of product (from the fishing vessel to the market and then to the buyer), creates delay which is usually at high ambient temperatures. This results in lower prices all round, wastage of product and poorer overall quality than might have been achieved by private sale directly from the fishing vessel to the processor. Obviously, this requirement would create other problems but overall benefits to both fishermen and processors can be obtained by such an arrangement.

Given a speedy delivery of raw material from the fishing sector to the processing plants, it is essential that the following points be observed during processing:

1. Speed of processing.
2. Maintain the product at the lowest possible temperature.
3. Keep the product on ice or in chilled water.
4. Ensure efficient hygienic procedures are adopted by staff.
5. Ensure all equipment is adequately cleaned and sanitized at least daily.
6. Maintain close analysis of the water used within the plant (preferably treat by sterilization).
7. Ensure adequate processing/freezing equipment is available.
8. Do not process quantities of product beyond plant's capacity.

Any plant processing seafood must ensure adequate toilet and washing facilities for its staff and see that these facilities are regularly used during the working day. Ensure that the plant operators' hands are kept clean whilst handling the product and that there is no likelihood of contamination from hair or clothing.

The proper disposal of plant and sewage effluent away from the plant is essential, as is the adequate supply of clean (unpolluted) water into the plant. Where possible, the treatment of water used in processing is advisable as a good insurance against accidental contamination. Care, however, should be exercised (if water is to be treated) to ensure against tainting of water caused by excessive use of hypochlorite etc. Care should also be exercised in the use of any additives or preservatives to ensure that the ultimate market for the processed product allows these to be used.

Sufficient equipment to handle the product is important, particularly equipment which is capable of freezing in a quick and efficient manner without adversely affecting the product. Any overloading of plant equipment or staff will only slow down the process line with adverse effects upon the finished product. Where cooking is related to seafood products, extra care must be exercised since import standards throughout the world are more severe on cooked seafoods because there are additional bacterial hazards.

Considering the present day value of seafoods, there are moves around the world to apply more rigid bacteriological, as well as commercial, standards upon all future imports; in this regard, closer examination of products for defects in processing, quality, grading and packaging are to be expected. The rapid expansion of the seafood industry did produce quite a number of compromises in quality during the past few years; I suggest that this casual approach is now ended. The high cost of re-handling sub-standard merchandise within the importing countries is now prohibitive and, therefore, the trend will move more and more towards greater quality control over purchases by the importing countries and buyers.

Up to now very little thought has been given to the packaging requirements; the cheapest available packaging has been considered sufficient. Invariably, this form of packaging has not been adequate to satisfy the first requirement of packaging (ie to protect the product) let alone produce consumer appeal. Very often, producers brands are not easily marketable within the ultimate market and might, in fact, actually create adverse reaction. Too often, seafoods have been sold from tropical areas entirely on the 'cheapest possible price' basis; this has not created any lasting benefits, rather the opposite. A large number of seafood exporters market through many importers; at times, this tends to produce weak markets, little customer goodwill and also little profit for re-investment in improved plant and machinery.

The overall trend in seafood processing development has frequently been one of quick over exploitation rather than orderly, maintained development. To create some order from this chaos, the following criteria seem desirable:

1. Some estimation of product availability.
2. Government licensing of plants related to the available raw material and suitable hygiene control over the finished products.
3. A suitable direct supply of raw materials from the fishermen to the processors.
4. Orderly marketing.

Regardless of whether there is a limit to the availability of seafood raw material in the future, the economic, let alone hygienic, requirements dictate the need for organization and control and not the haphazard development which has characterized so many seafood industries within the tropics in recent years.

# The frozen prawn industry of Malaysia

**Zahara Merican, A. Z. Idrus and A. Kamari**
Malaysian Agricultural Research and Development Institute, Malaysia

**Summary**

The frozen prawn industry earned US $ 47.2 million for the peak year 1973. This apparently lucrative business has attracted a large number of profit-orientated businessmen, with no proper premises or practical knowledge of processing, who have started competing with genuine processors. These unscrupulous ventures have given rise to poor quality products which form the basis of the complaints from importers. These complaints, together with rising prices and the poor economic situation, have led to a drastic reduction in Malaysian exports. The Government views the deterioration of the industry and the falling demand of the importing countries with concern.

The paper reviews the state of the frozen shrimp industry in Peninsular Malaysia. This includes Government involvements in the issue of health certificates, export permits, licensing and registration of factories through the implementation of the Code of Practice, and remedial action on the part of the processors to regain the reputation of Malaysian products overseas.

Problems associated with the industry have long been identified; studies are currently being undertaken by the Government to improve existing recommendations and to strengthen their implementation. Preliminary studies show that poor temperature control at loading and during shipment is a possible cause of the problem.

**Résumé**

L'industrie de la crevette bouquet congelée a atteint un chiffre de US $ 47,2 millions pour l'année record 1973. Ce commerce apparemment lucratif a attiré un grand nombre d'hommes d'affaires intéressés par le profit mais ne possédant aucune connaissance convenable des moyens de fabrication qui sont entrés en compétition avec des fabricants qualifiés. Ces aventuriers sans scrupule ont livré des produits de mauvaise qualité qui constituent le motif des plaintes des importateurs. Ces plaintes ainsi que l'élévation des prix et la mauvaise situation économique ont abouti à une réduction sévère des exportations Malaisiennes. Le Gouvernement s'est penché avec attention sur la détérioration de l'industrie et sur la baisse de la demande de la part des pays importateurs.

Cet article passe en revue la situation de l'industrie de la crevette congelée dans la Péninsule de Malaisie. Il fait état des interventions Gouvernementales dans la délivrance de certificats de salubrité, de permis d'exportation, de licences et d'enregistrement d'usines par la mise en application du Code de Pratique et il fait état des remèdes employés par les fabricants pour redonner une bonne réputation aux produits Malaisiens exportés.

Les problèmes associés à l'industrie ont été définis depuis longtemps et des études sont régulièrement entreprises par le Gouvernement pour améliorer les réglementations existantes et pour renforcer leur mise en application. Des études préliminaires montrent qu'un mauvais contrôle de la température au moment du chargement et pendant le transport représentent une des causes possibles du problème.

**Resumen**

La industria de gambas congeladas alcanzó un máximo de beneficios de US $ 47, 2 milliónes en el año 1973. Este aparentemente lucrativo negocio ha atraido a un gran número de comerciantes advenedizos, sin instalaciones adecuadas ni conocimientos prácticos de los procesos de elaboración, los cuales han empezado a competir con auténticos industriales. Estos negocios sin escrúpulos han dado lugar a la introducción en los mercados de productos de baja calidad, que son la base de las quejas de los importadores. Estas quejas, junto con el aumento de precio y la pobre situación económica han traido como consecuencia una drástica reducción de las exportaciones malayas. El Gobierno examina con preocupación el empeoramiento de la industria y la demanda decreciente de los países importadores.

El artículo hace una revisión del estado de la industria de camarones congeladas en Malasia peninsular. Ello incluye las implicaciones del Gobierno en la expedición de certificados sanitarios, permisos de exportación, licencias y registros de factorías por medio de la aplicación del

Código de Prácticas y la acción emprendida por los elaboradores para recuperar la reputación de los productos malayos en ultramar.

Los problemas asociados a la industria hace tiempo que han sido identificados, y actualmente se están emprendiendo estudios por parte del Gobierno para mejorar las normas existentes y reforzar su aplicación. Estudios previos muestran como posible causa del problema el control deficiente de temperatura durante la carga y el transporte marítimo.

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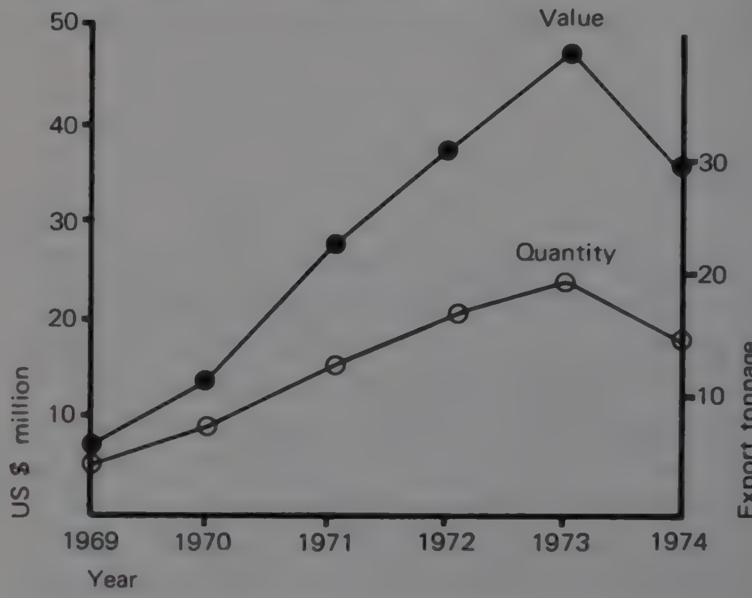
## Introduction

The total prawn catch for the Malaysian Peninsular is increasing every year; the figure for 1974 was 51,000 tons compared to 25,000 tons in 1967. These figures do not include the *Acetes* and mysid shrimp, comprising 19% of total landings (Labon, 1974); these smaller shrimp are used for the manufacture of belacan, a fermented shrimp paste, which is popular in Asia. Table 1 shows the six main prawn commodities exported to the various countries and their total value for 1974. It is obvious that frozen raw and frozen cooked prawns are the largest export commodity since they form approximately 80% of the total value of prawns exported.

The main export channel for fresh chilled prawns is direct trade with Singapore. Products such as dry salted prawns and belacan are traded directly with countries within SE Asia. Canned shrimp is a relatively new product, exported mainly to the developed countries, netting almost 10% of the total value of exported prawns. The last four items in Table 1 are non-perishable, preserved commodities which present few complications under normal trading circumstances. The main problems arise with the frozen prawn industry which earned US $ 47 million during the peak year (Figure 1).

This paper concentrates on the problems of the frozen prawn industry, discussing the situation which led to the poor image of the industry overseas, and the remedial action that has been adopted by the parties concerned to improve the market to its former level.

**Figure 1**
**Export of frozen prawns 1969–1974**



Source: Trade Div., Dept. Stats., personal communication.

## The frozen prawn industry

In 1967, when the industry was at the infant stage, there were 8 processing plants in the Malaysian Peninsular which exported frozen prawns; by 1971, the number had increased to 20. This booming industry encouraged the growth of back-yard industries in the fishing villages, especially in the North Western States of the Malaysian Peninsular. During the peak period (1973), there were as

TABLE 1. *Malaysian export of prawn commodities during 1974*

| *Commodity* | *Destination and quantity exported (tons)* | | | | | | | *Value* | |
|---|---|---|---|---|---|---|---|---|---|
| | *ASEAN** | *Japan* | *Hong Kong* | *USA* | *UK* | *Others*** | *Total* | *US $ x 10$^6$* | *%* |
| Fresh chilled | 5,340 | 24 | – | – | – | 10 | 5,374 | 2.94 | 7.52 |
| Frozen raw or cooked | 44 | 2,733 | 103 | 443 | 3,747 | 3,703 | 10,773 | 31.41 | 80.33 |
| Dry salted | 289 | 308 | 9 | – | – | 5 | 611 | 0.54 | 1.38 |
| Canned | 71 | – | 1 | 247 | 427 | 1,314 | 2,060 | 3.34 | 8.54 |
| Belacan (prawn paste) | 4,405 | – | 44 | | 1 | 325 | 4,775 | 0.62 | 1.58 |
| Prawn dust | 2,391 | – | – | – | – | – | 2,391 | 0.25 | 0.65 |
| *Total* | 12,540 | 3,065 | 156 | 690 | 4,175 | 5,357 | 25,984 | 39.10 | 100 |

*Association of South East Asian Nations (Indonesia, Philippines, Thailand, Singapore, Malaysia)
**Others include Australia, New Zealand, West Germany, Holland, Belgium, France, Italy, Sweden.

TABLE 2. *Prawn landings and number of frozen prawn factories in the Malaysian Peninsular for different states.*

| *State* | *Prawn landing (ton)* | *% of total landing* | *Number of factories* | | |
|---|---|---|---|---|---|
| | | | *1973* | | *1976* |
| | | | *licensed* | *unlicensed* | *licensed* |
| Perlis | 1,556.9 | 2.95 | 0 | 0 | 0 |
| Kedah | 2,625.5 | 5.15 | 0 | 0 | 1 |
| Penang | 7,666.6 | 14.85 | 12 | 27 | 17 |
| Perak | 19,662.5 | 38.60 | | | 9 |
| Selangor | 13,900.4 | 27.45 | 4 | 3 | 5 |
| North Sembilan | 4.8 | 0.01 | 0 | 0 | 0 |
| Malacca | 44.1 | 0.08 | 0 | 0 | 0 |
| Johore | 4,119.9 | 8.10 | 1 | 0 | 1 |
| Kelantan | 218.6 | 0.45 | 0 | 0 | 0 |
| Trengganu | 351.8 | 0.70 | 0 | 0 | 0 |
| Pahang | 836.4 | 1.65 | 0 | 0 | 0 |
| *Total* | 50,997.5 | 100.00 | 47* | | 33 |

***Source: Ministry of Trade and Industry, personal communication.**

many as 47 companies exporting frozen prawns (Table 2). Most of these factories did not qualify for licensing by the Health Authorities or Local councils although they could be registered as business companies and were able to export their products. This situation arose due to the procedures involved in the licensing (by the Ministry of Health and Local Authority) and registration of companies (by the Ministry of Trade and Industry).

Isolated complaints against frozen prawns exported from Malaysia were received by the Ministry of Trade and Industry as early as 1970. The nature of the complaints were high bacterial counts, high levels of coagulase-positive *Staphylococcus aureus* and the excessive presence of faecal coli in the majority of the consignments. The complaints had worsened by 1974 and were especially directed towards cooked and peeled frozen prawns which are used for direct consumption as cocktail dishes without further cooking. As a result, Malaysian shipments have been singled out for thorough examination by the respective Health Authorities of the importing countries.

During the initial years of exportation, the factories were very antagonistic towards one another, co-operation was impossible and competition between them was very high. To overcome this unhealthy situation, six processors formed the Malaysian Frozen Food Association in 1970 (Malaysian Frozen Food Association, personal communication). At present, almost all processors are members of the Association which represents the industry at ministerial level meetings although individual participants are also entertained. Communication between the enforcement sectors and the industry is made easier through this Association.

## Present situation

### *Government involvement*

Frozen prawns are one of the many food commodities which require quality inspection. The Government views foreign complaints on the deteriorating quality of the exported Malaysian prawns with concern. A committee, consisting of representatives of the various Ministries, relevant quasi-government bodies and the frozen prawn processors, was formed in 1974 to identify and solve the problems of the industry. A guideline, in the form of a Code of Practice for the Export of Frozen Cooked Prawns, was recommended by the committee as an immediate solution to restore the overseas image of the industry (Ministry of Health, 1975b). This was made mandatory to exporters from April 1975 and the following microbiological standards for frozen cooked prawns must be met:

| | |
|---|---|
| Standard plate count (SPC) | 250,000/g |
| *S. aureas* | $<$ 1,000/g |
| *Salmonella* spp. | nil/50g |
| *Escherichia coli* | $<$ 10/g |

Concurrently, a project to help the industry was undertaken by the Agricultural Product Utilization Division of the Malaysian Agricultural Research and Development Institute (MARDI) with the help of two experts from the UK. Several aspects of the industry were looked into and detailed recommendations were presented to the Malaysian Government (TPI, personal communication). It should be pointed out that during this study the Code of Practice was in the drafting stage and a Standard was undergoing revision (Standards Institute of Malaysia, 1971). Following the recommendations in this report, the Malaysian Government and the frozen prawn exporters are anticipating long-term assistance from the UK to alleviate the manpower problems that Malaysia is facing.

The Industrial Co-ordination Act (ICA), 1975, was passed by Parliament in April 1975 and received the Royal Assent on 15th May 1975 (Ministry of Trade and Industry, 1975). Under this Act, all manufacturing activities, including food processing, will be required to obtain licences. The Act is also aimed at the prevention of wasteful competition in industries like those handling seafoods where the entry of too many companies has resulted in over capitalization and misallocation of resources.

General legislation under the sale of Food and Drugs Ordinance and Regulations has existed since 1952. No major amendments were made to the Ordinance except for some minor alterations, the latest being passed by Parliament in 1975 (Ministry of Health, 1975a). The Government recognized the necessity to tighten the enforcement of these regulations; however, the acute shortage of manpower is forcing the Government to determine priorities in carrying out these recommendations. The Food and Drug Committee is currently making a major review of the Ordinance to rectify the existing inadequacies; the amendments will again be implemented in stages.

### *Export control and licensing*

All processing plants are required to be licensed either by the Ministry of Health or by the Local Authority, depending on their location. The factories are regularly inspected by the Health Authority (at least twice a year) to maintain proper sanitation and hygienic conditions. The use of an evaluation schedule rating system has been introduced since the beginning of 1975 (Ministry of Health, personal communication). This method allows a more standardized quantitative comparison to be made between premises and between visits of the same premises.

A Code of Practice for Hygiene and Sanitation of Food Premises is being prepared by the Ministry of Health and is under final review (Ministry of Health, 1976). This comprehensive code is designed to cover minimum standards for a wide range of food establishments (ranging from eating places to places of manufacture, processing, preparation and sale); it is also to protect food during transportation, production, storage etc.

Health Certificates are issued for consignments from licensed factories only on condition that the bacteriological quality of five random samples of the consignment meet all specifications in the Code of Practice. The following Health/Medical officers are authorized to issue Health Certificates: the Director of Medical and Health Services of all States, the Medical Officer of Health in the District Health Office, the Port Health Officer in Port Klang and Penang and the Health Officers stationed in the major towns. With the Health Certificate from the Ministry of Health, the processor now requires an export permit for his consignment.

### *Sampling and analysis*

The exporter is required to give adequate notice to the Health Office for samples to be taken from each consignment prior to shipment. A Health Inspector will be directed to collect random samples from the factory using statistical sampling plans. For each consignment, five whole (unbroken) packs will be sampled; the packs, inclusive of their wrappers, are sealed in polythene bags and are iced in suitable containers to maintain a low temperature during transit. These samples are sent immediately for analysis to Government laboratories (Institute of Medical Research or Chemistry Department) or private laboratories, which have been accredited to fill in the present shortage of technical facilities in Government institutions. Laboratory reports are communicated directly to the Health Office and Health Certificates are issued on Standard Health Certificate formats if the results of microbiological analysis comply with those specified in the Code of Practice.

Currently, only two private laboratories meet the requirements for microbiological analysis and have been accredited by a subcommittee under the Ministry of Health. Spot checks are carried out to ascertain that standards are maintained by these laboratories.

### *Transportation and shipment of consignments*

Consignments for export are required to be transported, ideally in refrigerated trucks/containers, however, if ordinary trucks are used, the consignments must be carried in insulated containers which are cooled with clean chipped ice. The temperature of the consignments during transportation is not allowed to exceed –12°C; the temperature is checked by the agency which insures the consignments from the port of loading to the point of inspection by the importing Port Authority.

## **Problems faced by the industry**

### *Raw materials*

From Figure 2 it can be seen that there is a well-defined period of low prawn landings during September and October (Ministry of Agriculture and Rural Development, 1975a). It has been observed that during this period prawns are imported, from the proximate areas of neighbouring states, by the processors to maintain their production.

**Figure 2**
**Landing of prawns (tons) by month in 1974**

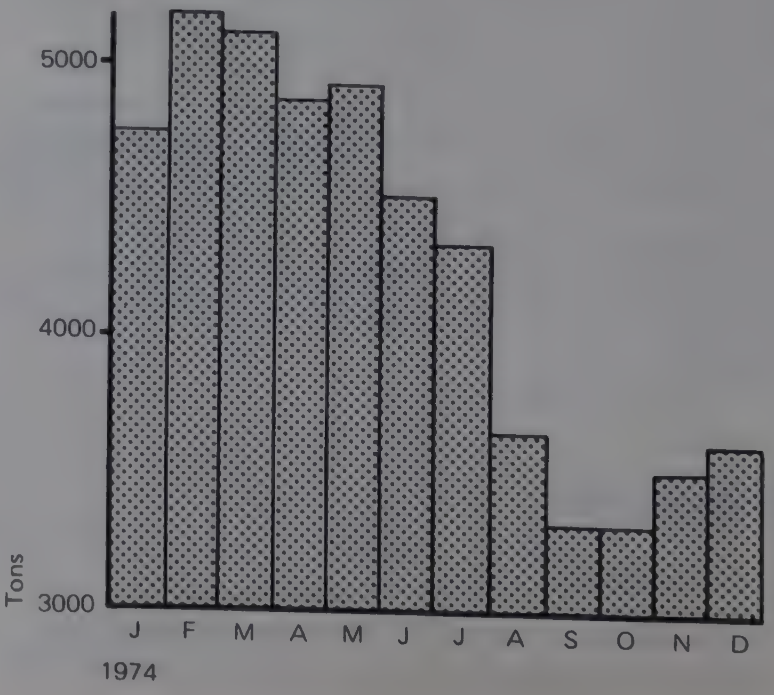
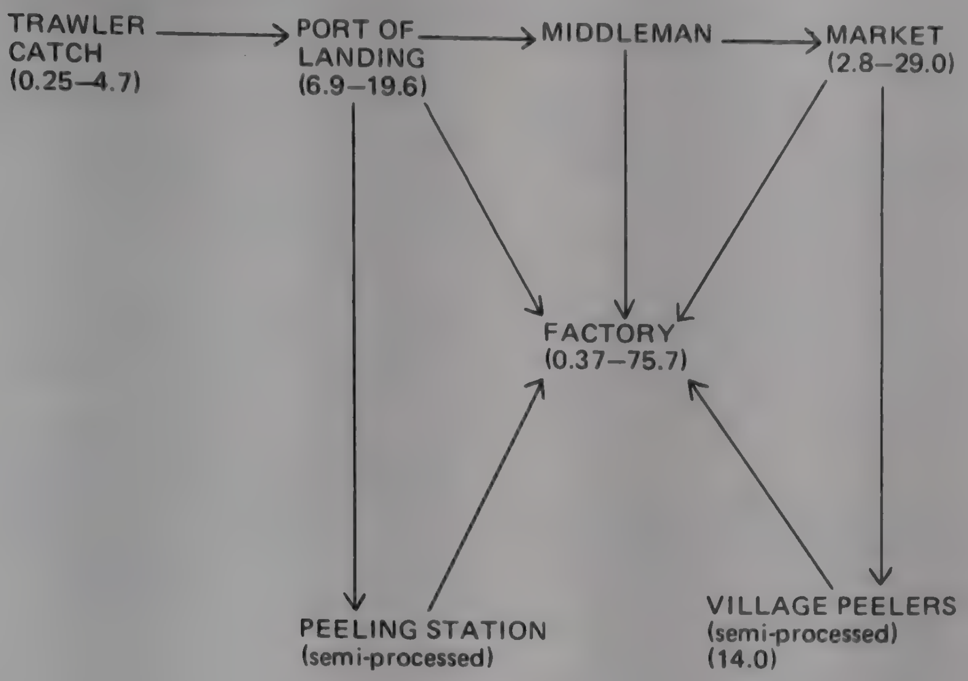


**Figure 3**

**Sources of raw material: increase in standard plate count ($\times 10^6$/g) at 37°C along the processing chain.**


TRAWLER CATCH (0.25–4.7)
PORT OF LANDING (6.9–19.6)
MIDDLEMAN
MARKET (2.8–29.0)
FACTORY (0.37–75.7)
PEELING STATION (semi-processed)
VILLAGE PEELERS (semi-processed) (14.0)

Prior to processing, as much as 50% of the prawns imported through the Northern States of Peninsular Malaysia were discarded by the processors. The bacteriological quality of the prawns from Thailand, after selection, is not significantly worse than Malaysian prawns (TPI, personal communication). However, it can be inferred from the high percentage of discarded prawns that the quality has deteriorated due to the longer transportation and handling time needed to reach the Malaysian market. These discards are not wasted; several processors pack them as 'bait prawns' and send them to markets in Australia and Europe. This is one industry which has no wastage material: the shells, heads and other discards from the factory are sold to fishmeal processors.

Another problem area is the existence of back-yard industries which provide employment for casual (non-permanent) peelers. These back-yard factories are merely sheds and are barely equipped for the production of acceptable products. Their growth is largely due to the shortage of labour (during the padi harvesting seasons) and of good quality prawns.

These back-yard factories either operate independently or are 'peeling stations' supported by the larger concerns to supply peeled prawns (though of poorer quality) to meet export commitments. Sub-standard prawns are processed at the 'peeling stations' in villages since they would be rejected at the factories due to the poor physical state; however, after processing, the appearance of the products is seemingly 'improved' and accepted by the factories. The implementation of the Code of Practice (1975) was designed partly to curb the practice of illegal processing outside licensed premises.

In many instances, the time delay between capture and processing can be considerable. At present, the quality of the raw material is quite difficult to control. From Figure 3, it can be seen that the bacterial load increases significantly throughout the processing chain due to improper handling. It is hoped that, with the introduction of the Fisheries Development Authority Act, gazetted landing areas will be under direct surveillance of the above Authority and problems of handling, storage and transportation will be minimized.

Raw materials are supplied to the factories by middlemen and prices are negotiated on a weekly basis. Competition for the raw material exists and is quite acute, especially during the slack periods. This is the major reason for the purchase of semi-processed prawns. By restricting the number of factories in accordance with the catch through the ICA, it is hoped that a sufficient supply of raw materials will be ensured to each processor.

### *Handling and transportation*

The handling of raw prawns is very poor. Insufficient ice is used, especially on board the fishing vessels, and the initially high bacterial load has been shown to increase fourfold by the time the prawns are landed (TPI, personal communication). The prawns are sometimes left on deck exposed to the sun and high temperatures. The baskets (or other containers) and the deck are highly contaminated and are seldom cleaned; if cleaning is carried out, hosing with water is the only method used. Fish slime is allowed to accumulate especially on the containers. Furthermore, some of the catches are not sorted until landing and, since the catch is seldom washed, cross-contamination between prawns and fish occurs.

At the processing plant also, handling of the raw material is often poor. The ice used during transportation and processing is frequently of poor quality due to mishandling of good quality ice. Badly designed plant layouts in some factories also result in a high incidence of cross-contamination.

### *Recent developments*

Following the implementation of the Health Certificate in 1975, it was understood that marketing conditions had improved and that cooked/peeled frozen prawns were being exported successfully to Europe, the UK, the USA and New Zealand (New Zealand had previously banned

Malaysian products because the quality was poor). There were, however, still cases of rejection, even after the enforcement of the Code of Practice (also in 1975) and recently a meeting of relevant government agencies and processors was held to discuss rejection complaints from the UK. The various possible causes for the contamination were discussed and an indepth study will be undertaken to identify the actual areas. The Malaysian Trade Commission in London and the exporters are requested to investigate the rejection from both ends. The exporters are particularly worried about the high rejection rate for fear of refusal from insurance companies; higher premiums have already been imposed on several exporters.

A preliminary check at the port of loading reveals that, during loading, the temperature of the prawns is being checked by the insurance agents and is not allowed to exceed –12°C. However, the ship's freezer is switched off to enable workers (who are not provided with protective clothing to work under freezing conditions) to load the prawns. The freezer is operated only after it is fully loaded, which takes from 5 to 25 hours. Waiting at the port of loading in unrefrigerated containers under tropical conditions is another possible cause of temperature increase. Breakdown of the ship's freezers during the journey may occur. The conditions on board ship, and at the port of importation, are not well known and certain exporters are sceptical about the assumption that these conditions are perfect. These occurrences are suspected of contributing to the increase in the bacterial count after consignments leave the factories.

## Conclusions

Government intervention is undoubtedly necessary to enforce regulations to upgrade quality in the industry. However, it is felt that the processors themselves should be more quality conscious, rather than being excessively profit motivated, to maintain their products in the competitive market. The industry has realized that maintenance of quality is essential and has recognized the Government's efforts to protect them in the world market. A committee, comprising the various government and quasi-government agencies, was set up to look into the industry's problems and it is actively studying the situation.

A co-ordinated effort between the Malaysian Frozen Food Association and the related agencies is essential in solving intermittent problems faced by the industry. Further work to improve the quality of frozen prawn exports is proposed by MARDI; this should include co-operation between MARDI, the Fisheries Department, the Ministry of Health, the Ministry of Trade and Industry and the exporters.

Since a large part of the bacteriological contamination occurs prior to processing, the raw materials, handling and transportation need to be improved. Looking at the fishing industry as a whole, this may be difficult to achieve. However, with the enforcement of the Fishery Development Authority Act, it is hoped that the quality control of raw material can be effected in stages. Similarly, the design of factories and processing equipments should be modernized.

It is realized that several new Acts and policies to improve the industry have been introduced recently. However, it should be stressed that, for the implementation of these Acts, enforcement needs to be effective to ensure the industry's continued growth.

## Acknowledgements

The authors wish to acknowledge the help provided by the Department of Fisheries, the Ministry of Agriculture, the Ministry of Trade and Industry, the Ministry of Health and the Malaysian Frozen Food Association. The kind permission of the Director of MARDI is also appreciated.

## References

**Labon, A.** (1974) Malaysian Long-term Fisheries Development Plan until 1975. FAO/UNDP

**Ministry of Agriculture and Rural Development, Malaysia** (1975a) Annual fisheries statistics.

**Ministry of Agriculture and Rural Development, Malaysia** (1975b) Statistics on import and export trade in food and agricultural products.

**Ministry of Health, Malaysia** (1975a) The Sale of Food and Drugs Ordinance and Regulations, 1952.

**Ministry of Health, Malaysia** (1975b) Code of practice for the export of frozen cooked prawns.

**Ministry of Health, Malaysia** (1976) Code of practice for hygiene and sanitation of food premises (to be published).

**Ministry of Trade and Industry, Malaysia** (1975) The Industrial Co-ordination Act (to be published).

**Standards Institute of Malaysia** (1971) MS 35 Specification for frozen shrimp.

# Biochemistry and physiology of shrimp: effect on use as food

**B. F. Cobb III***
Texas A and M University, USA

## Summary

Most investigations on shrimp quality have tended to concentrate upon the effects of bacterial growth; this paper attempts to consider the role of natural enzymes and physiology of the shrimp on quality.

Physiological phenomena, such as the moulting cycle and osmo-regulation, are shown to have potentially significant effects upon shrimp quality. The state of knowledge on the post-mortem biochemistry of shrimp muscle is reviewed and is related to the development of melanosis (or blackening) in shrimp. Undoubtedly, the establishment of a viable mariculture industry will increase the pressure for more information on the biochemistry of shrimp in relation to quality parameters.

## Resumen

Les recherches sur la qualité de la crevette ont eu tendance à se concentrer sur les effets de la croissance bactérienne; cet article se propose de prendre en considération les effets des enzymes naturels et la physiologie de la crevette ainsi que leurs effets sur la qualité de la crevette.

Les phènoménes physiologiques tels que le cycle de transformation et l'osmorégulation se sont avérés posséder des effets potentiellement significatifs sur la qualité de la crevette. L'état des connaissances sur la biochimie post mortem du muscle de la crevette est passé en revue et particulièrement dans ses rapports avec le développement de la melanose (ou noircissement) de la crevette. Sans aucun doute, l'installation d'une industrie de pisciculture viable augmentera le besoin d'une meilleure information sur la biochimie de la crevette par rapport aux paramètres de qualité.

## Resumen

La investigaciones sobre la calidad de los camarónes se han concentrado sobre los efectos del desarrollo de bacterias. Este artículo trata de considerar el efecto de las enzimas naturales y la fisología de los camarónes y su efecto sobre la calidad de los mismos.

Se demuestra que fenómenos fisiológicos tales como el ciclo de muda y la osmoregulación tienen un efecto potencial importante en la calidad de los camarónes. Se revisan los conocimientos actuales sobre la bioquímica del músculo del camarón después de muerta, relacionándolo sobre todo con el desarrollo de la melanosis (o ennegrecimiento) del camerón. El establecimiento de una industria viable de maricultura incrementaría las exigencias de mayor información sobre la bioquímica de los camarónes en relación con los parámetros de calidad.

## Introduction

The shrimp fishery is, economically, one of the most important fisheries in the United States. The present selling price of shrimp places them in the gourmet price range. However, shrimp quality often falls far short of the quality expected for a gourmet product.

Although a large number of investigators have looked at factors affecting shrimp quality, few have attempted to differentiate between effects caused by natural enzymes and/or physiology of the shrimp from those caused by post-mortem bacterial growth. The shrimp is a member of the phylum Arthropoda. It resembles an insect in its biochemical and physiological characteristics more closely than it does a teleost fish, however, very few investigators working on technological problems in shrimp have consulted the large volume of insect literature. In this paper, we try to point out some areas where insect work can provide valuable insights into problems which affect the use of shrimp as food.

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* The editors note, with regret, that B. F. Cobb III has died since the TPI Conference.

The shrimp abdomen (usually called the tail in commercial circles) is the portion most often consumed; it consists largely of muscles with cross-linked fibres, (Atwood 1972). Very little is known about shrimp muscle proteins and the subsequent changes they undergo during refrigerated storage. Lightner (1973) has described post-mortem changes in shrimp tissue maintained at temperatures ranging from 10–30°C.

The hindgut (or sand vein), which runs through the abdomen, often contains bacteria, partially digested material, digestive enzymes and sand. In the female, the hindgut is surrounded by ovaries, which may constitute a sizable portion of the shrimp weight. Brown and Patland (1974) have published a series of photographs which illustrate the size of penaeid shrimp ovaries very vividly. Autodigestion of the hindgut results in bacterial invasion, destruction of tissue and, undoubtedly, promotes spoilage (Carroll *et al.*, 1968).

Near the outer edge of the abdomen is a tough layer of epidermis which contains a large amount of pigment, usually melanin and/or astaxanthin (Katayama *et al.*, 1972).

The cephalothorax (often called the head), which is not used for food in the USA, contains a high level of digestive enzymes; evidence for this is the rapid autodigestion of the links between the cephalothorax and the abdomen. The cephalothorax also contains about 50 to 80% of the bacterial population of the shrimp (Green, 1949b; Williams *et al.*, 1952). Consequently, failure to remove the cephalothorax and to wash the digestive enzymes from the abdomen may result in rapid spoilage. This has been disputed by Koburger *et al.*, (1974); however, reports by Green (1949a) and experiments by students at Texas A and M have indicated that head-on shrimp have a shelf life of approximately 5 days compared with 14 days or more for beheaded shrimp. The cephalothorax may also contain high levels of melanin precursor which, if not removed, may stain the meat in the abdomen and, therefore, lower its quality when melanin production occurs.

## Significance of the moulting cycle

In order to grow, the shrimp must shed the exocuticle; the moulting cycle for shrimp is briefly described in Table 1. The biochemical events of the moulting cycle are complex and have not been fully elucidated; those that are known, however, suggest that many of the technological problems associated with shrimp may be the result of various events occuring during the moulting cycle.

Probable technological problems associated with the moulting cycle in shrimp are listed in Table 2. The relationship between the moulting cycle and melanosis has not been recognized by most investigators. During the inter-moult period, the shrimp builds up melanin precursor, probably a 3-o-phosphate or 3-o-sulphate derivative of N-acetyldopamine as in the insect (Bodnaryk *et al.*, 1974). Preliminary date indicate that deproteinated shrimp extracts incubated with o-diphenol oxidase (EC 1.14.16.1) and orthophoshoric-monoester phosphohydrolase (EC 3.1.3.2) tend to develop more

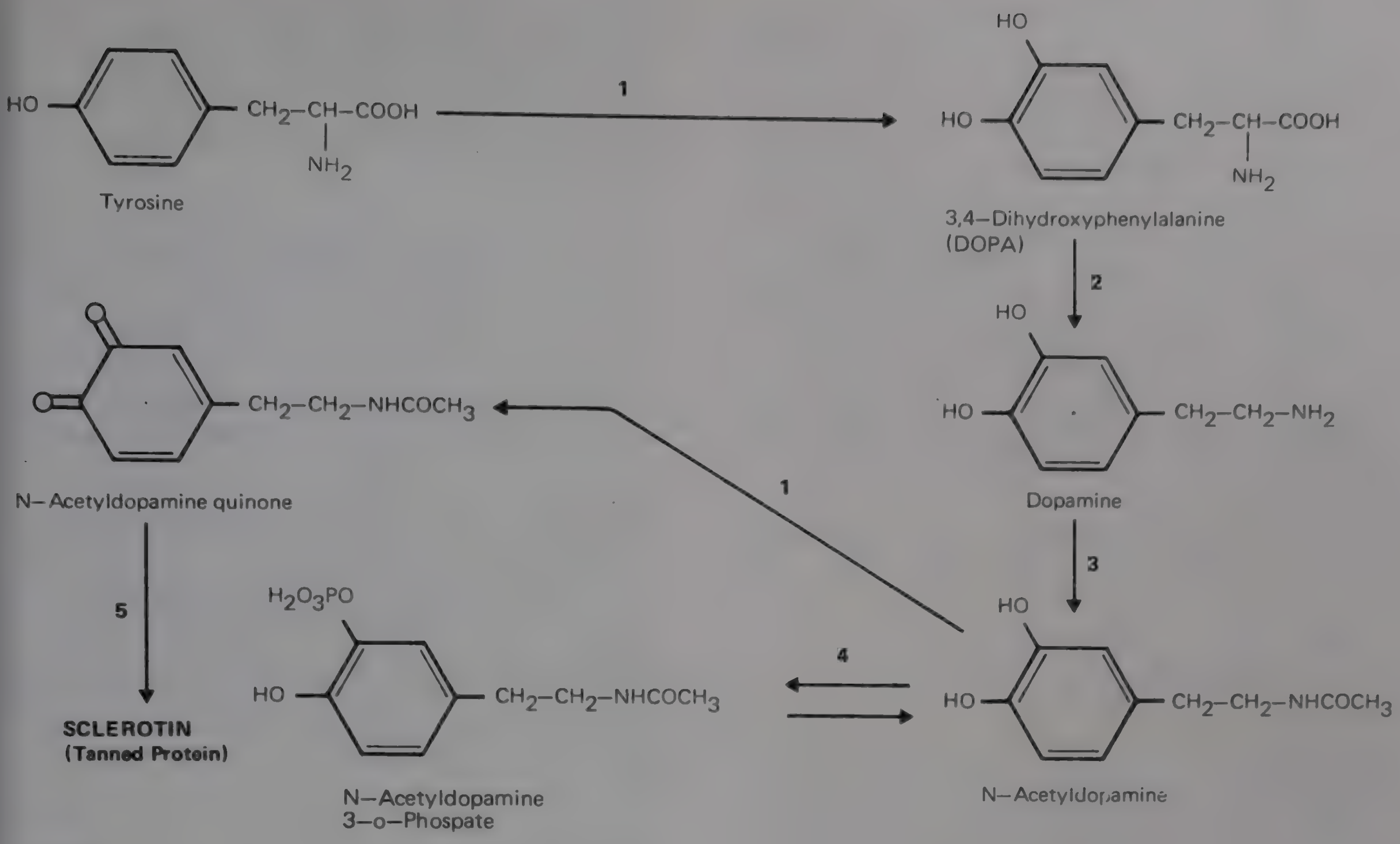
TABLE 1. *Events of possible technological significance occuring in the moulting cycle of shrimp*

| *Stage of moult* | *State of cuticle* | *Event* |
|---|---|---|
| Post-moult | Initially soft becoming increasingly harder | Continued water absorption<br>Tissue growth begins |
| Inter-moult | Hard | Main tissue growth<br>Accumulation of melanin precursor (storage form of N-acetyldopamine) and other organic reserves. |
| Pre-moult | Hard but gradually thinned | Epidermal and hepatopancreas activation<br>Activation of N-acetyldopamine precursor<br>Epicuticle formation begins utilizing N-acetyldopamine<br>Major portion of skeletal re-absorption<br>Ecdysial sutures open |
| Moult | Soft | Beginning water absorption |

TABLE 2. *Possible technological effects of the moulting cycle on penaeid shrimp*

| *Stage of cycle* | *Technological effects* |
|---|---|
| Post-moult | Difficulty in sorting and peeling<br>More rapid spoilage<br>Broken or mis-shapen shrimp<br>Excessive weight loss on cooking<br>Excessive weight loss during processing |
| Inter-moult | Difficulty in peeling (early stage)<br>Melanosis (latter stage)<br>Toughness (latter stage) |
| Pre-moult | Melanosis<br>Toughness |
| Moult | Same as for pre-moult stage |

**Figure 1**
**Role of phenols in formation of new cuticle.**



Enzymes

**1** o–Diphenol oxidase

**2** Dopadecarboxylase

**3** Transacetylase

**4** Phosphatase

**5** Tanning Enzyme

melanin pigment than extracts incubated with o-diphenol oxidase alone (Cobb, unpublished data). N-Acetyldopamine polymerizes and reacts with proteins to form the new sclera (Figure 1). The build-up or activation of catabolic enzymes prior to moulting undoubtedly has technological significance but, at present, data are not available on its role in quality deterioration.

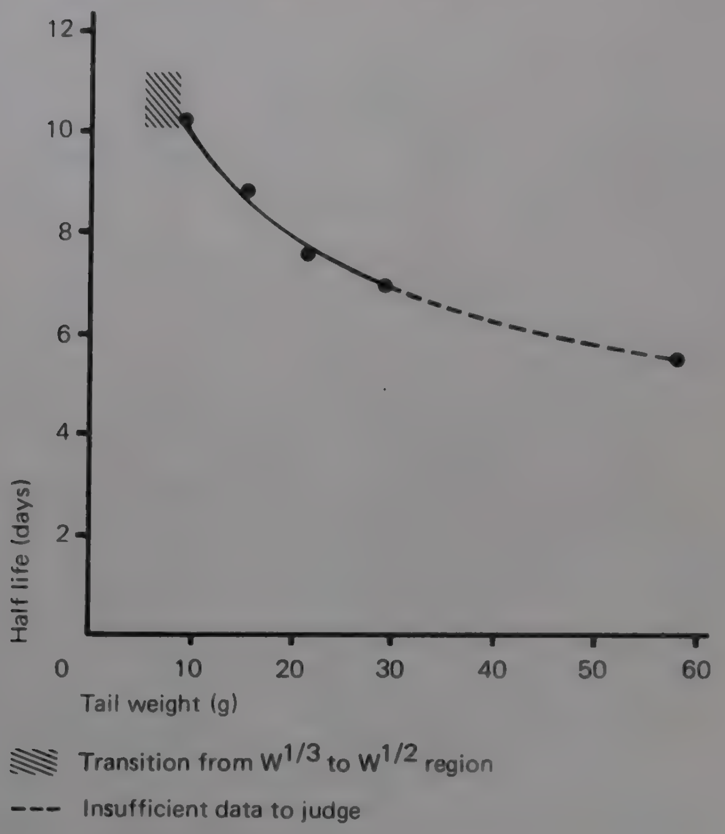
Recently, a five pound box of shrimp, opened in our laboratory, illustrated dramatically the problems associated with moulting. Approximately one third of the shrimp had old shells and a large amount of black discoloration (melanosis). Another third had shells which were beginning to loosen or had already been shed. None of these shrimp had melanin development, but those with shells which were just beginning to loosen had a tough unappealing outer surface when cooked and peeled; the 'soft-shell' shrimp in this group were mashed and broken. The final third of the shrimp had new shells and no melanin development; they appeared to shrink considerably when cooked.

Increasing evidence suggests that penaeid shrimp moult during the dark of the moon and most of the shrimp in a rapidly growing population appear to moult at about the same time (Cobb, unpublished data). Unfortunately, we probably cannot schedule harvesting of wild shrimp at the time during the moulting cycle which would produce the best quality product. Also, very large shrimp moult only occasionally and this makes estimation of the proper harvesting time difficult. Shrimp culture operations, however, could take advantage of this knowledge to produce shrimp of a superior quality from rapidly growing populations; such shrimp would have to be harvested during the inter-moult stage. We are presently working on enzyme markers which we feel will eventually allow us to determine the exact time for harvesting mariculture shrimp.

### The role of osmo-regulation

A number of investigators have noted the relationship between salinity and free amino acid content in crustaceans; many of these studies have been recently reviewed by Schoffeniels and Gilles (1970). Glycine and proline are the main osmo-regulators in penaeid shrimp with alanine playing a less certain role (Cobb *et al.*, 1975). Glycine has been identified as the cause of the sweet taste in shrimp (Hashimoto, 1965; Rajendranathan Nair and Bose, 1965). Unfortunately, glycine is washed from ice-stored shrimp at a logarithmic rate which is a function of the cube root of the weight of the abdomen in larger shrimp and the melting rate of ice (Cobb *et al.*, 1976); the rate of loss increases with shrimp

Figure 2
Calculated half-life of free amino acids in shrimp stored on ice.



size. Half-life of the glycine content of larger shrimp is usually less than seven days (Figure 2). The simultaneous loss of ammonia and free amino acids has been used to develop a chemical test for shrimp quality (Cobb *et al.*, 1973; Cobb and Vanderzant, 1975). Loss of free amino acids and, hence, flavour through the washing action of melt water is offset by the removal of ammonia, melanin precursor and bacteria.

In the moult and post-moult stages, shrimp take in fluid to expand and fill the new shell. Since glycine and proline are mainly responsible for osmo-regulation, the shrimp either have to make more glycine and proline available or maintain a high salinity in the body fluids which could disrupt muscle proteins.

Preliminary evidence suggests that the free amino acid content in shrimp is rapidly increased when moulting occurs. Experiments to determine the rate at which the free amino acid content changes when shrimp are challenged with lower salinities have been conducted (Cobb and Conte, unpublished data). When inter-moult shrimp were challenged with salinity changes, based on a constant water content in the shrimp, there was a rapid linear decrease in free amino acid content. However, when the same experiments were conducted with moulting shrimp, free amino acid levels were very eratic and generally much higher than in inter-moult shrimp. This indicated that free amino acid content increased rapidly during moulting. This increase, relative to other components in newly moulted shrimp, suggests that these shrimp might be more flavourous than those in the later stages of moult.

## The role of proteolytic enzymes

Cobb *et al.* (1974) reported considerable anabolic (amino acid producing) and catabolic (amino acid reducing) activities in post-mortem shrimp tails. Eitenmiller (1974) found cathepsin D-type activity in *Penaeus setiferus* muscle but very little activity was evident in the pH 7 to 8 range, the normal pH range of post-mortem shrimp. Arylamidase activity, which may be responsible for intracellular catabolism of proteins, has also been detected in *P. setiferus* muscle (Bauer and Eitenmiller, 1974a and b). Considerable activity was evident in the pH 7 to 8 range.

Tryptic activity in the digestive juices of penaeid shrimp has been studied (DeVillez and Buschlen, 1967; Gates and Travis, 1969 and 1973). The optimum pH of shrimp trypsin was rather broad, occurring over the range 7.0 to 9.5. Digestive enzymes would be important in the hindgut and on the anterior portion of the abdomen due to contamination during removal of the cephalothorax.

Proteolytic digestive enzymic activity levels have been demonstrated to vary with the stage of the moulting cycle and season in *Palaemon serratus* (Van Wormhoudt *et al.*, 1972 and 1973). Presumably, these levels would be higher in 'feedy' than in 'non-feedy' shrimp. Obtaining shrimp at a period of low levels of digestive enzyme activity may have allowed Koburger *et al.* (1974) to keep head-on shrimp on ice for longer periods than normally reported by other investigators.

## Post-mortem changes

### *Ammonia and urea production*

During ice storage, ammonia is produced in penaeid shrimp muscle at the rate of approximately one milligram per day (Cobb *et al.*, 1974) and is simultaneously leached from shrimp at a logarithmic rate resulting in little apparent increase. Urea (produced by the action of arginase) and glycine are leached at the same rate as ammonia; this allows the development of a series of equations for estimating endogenous enzymic activity in intact shrimp tails.

Enzymic production of ammonia during ice storage causes the pH of shrimp muscle to rise from about 7.0 to slightly above 8.0 (Bailey *et al.*, 1956; Bethea and Ambrose, 1962; Vanderzant and Nickelson, 1971). This in turn causes an increased production of ammonia since the optimum pH for the main ammonia producing enzyme(s) is approximately 8.5 (Yeh and Cobb, unpublished data).

While working with commercially 'fresh' shrimp (probably not freshly caught), urease activity was detected (Cobb and Vanderzant, 1971). Subsequent investigations have indicated that, although the enzyme system which produces ammonia in post-mortem shrimp has some similar properties to urease, it probably is not this enzyme. The initial urease activity detected may have been from bacteria. Ammonia production from bacterial urease may become important during the latter stages of ice storage, particularly if sufficient urea has not been leached from the shrimp.

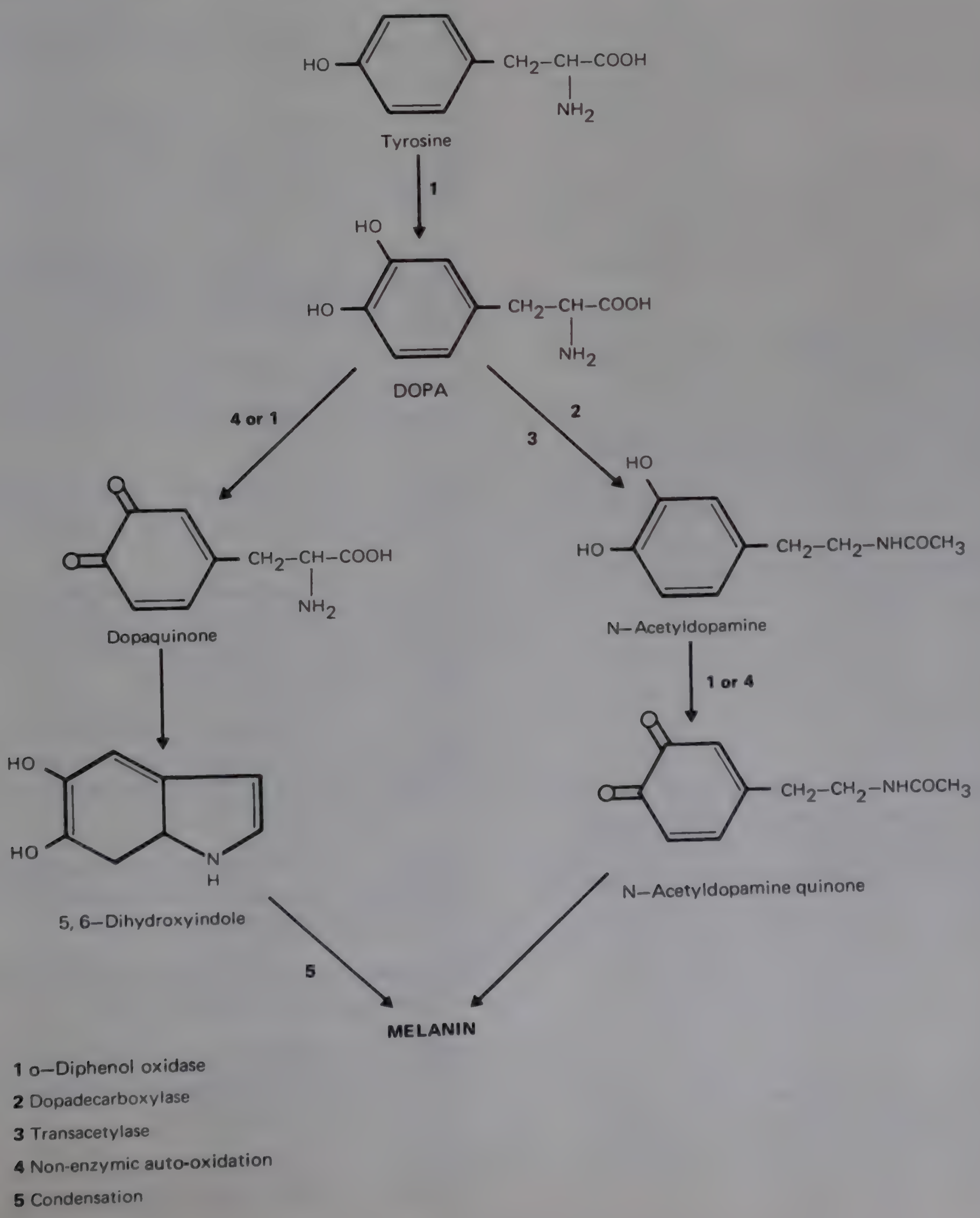
### *Melanosis*

We have already briefly examined the relationship between moulting and the build-up of melanin precursor which is, undoubtedly, either dihydroxyphenylalanine (DOPA), a derivative of DOPA such as N-acetyldopamine in which the dihydroxy ring is unaltered, and/or a stable storage form such as a 3-o-phosphate derivative. The melanin precursor is located near the periphery in the shrimp tail and is rapidly removed by washing (Cobb *et al.*, 1976). As is shown by the rapid darkening, considerable melanin precursor may be stored in the cephalothorax.

It is uncertain whether post-mortem melanin formation is due to enzymic or non-enzymic oxidation. It is also uncertain whether one enzyme or several are involved in the oxidation of tyrosine and DOPA or DOPA derivatives. Further confusion is imparted by the variety of names used for the enzyme o-diphenol oxidase: tyrosinase, phenolase, phenol oxidase, polyphenol oxidase and catechol oxidase. In addition to o-diphenol oxidase, the various enzymes reported to play a role in the oxidation of phenols in arthropods are tyrosine hydroxylase, laccase, polyphenol peroxidase and tyrosine peroxidase (Neville, 1975).

Monohydric phenols, such as tyrosine, are fairly stable to chemical oxidation while dihydric phenols, such as DOPA, are very unstable and readily undergo oxidation, forming coloured polymers in the process (Figure 3). The auto-oxidation of dihydric phenols is catalysed by light. DOPA is oxidized to dopaquinone, either by enzymic or non-enzymic means, and then undergoes rearrangement and ring formation to form 5, 6-dihydroxyindole which then forms melanin (Neville, 1975). N-Acetyldopamine also forms melanin. Sodium bisulphate, a reducing compound, has been employed for years

**Figure 3**
**Post-mortem formation of melanin in shrimp**


HO
CH2–CH–COOH
NH2
Tyrosine
1
HO
HO
CH2–CH–COOH
NH2
DOPA
4 or 1
2
3
HO
HO
CH2–CH2–NHCOCH3
Dopaquinone
CH2–CH–COOH
NH2
N–Acetyldopamine
1 or 4
HO
HO
N
H
CH2–CH2–NHCOCH3
5, 6–Dihydroxyindole
N–Acetyldopamine quinone
5
MELANIN
1 o–Diphenol oxidase
2 Dopadecarboxylase
3 Transacetylase
4 Non-enzymic auto-oxidation
5 Condensation

to inhibit melanin development. Bacteria also tend to inhibit melanosis in shrimp (Cobb and Vanderzant, 1971). Quinones or quinone polymers readily condense with amino groups on proteins in an irreversible tanning process, once the pigment is bound, it cannot be removed without destruction of the protein.

When the shrimp are near moulting or are taken from organic-rich waters, they may blacken excessively particularly if the washing action of melted ice is absent (Cobb and Vanderzant, 1971; Vanderzant *et al.*, 1973; Cobb *et al.*, 1976). The tendency for shrimp to darken more readily in organic-rich waters has also been reported by fishermen. This phenomenon may be a reflection of the more abundant foodstuff in these waters which promote more rapid growth, and therefore, more frequent moulting.

### *Nucleotide degradation*

Flavour and probably texture of shrimp are influenced by post-mortem nucleotide breakdown. Stone (1971) and Flick and Lovell (1972) have demonstrated that the breakdown of nucleotides is as follows: adenosine triphosphate (ATP) is degraded in sequence to adenosine diphosphate (ADP), adenosine monophosphate (AMP), inosine monophosphate (IMP), inosine (Ino) and hypoxanthine (Hx). The exact consequences of the conversion of ADP and IMP to Hx are unknown but this probably results in the loss of meaty flavour (Hashimoto, 1965; Jones, 1969) and may also result in bitterness as observed by Carroll *et al.* (1968). Whether or not nucleotides are leached from shrimp during ice storage at or near the same rate as amino acids has not been established.

The loss of ATP should induce rigor in shrimp as has been reported by Lightner (1973). However, Flick and Lovell (1972) reported that rigor was not observable in shrimp. Recent studies of myograph measurements in our laboratory have established that rigor definitely occurs in shrimp (Wilaichon, 1976). These studies have also indicated that there might be a relationship between toughening and rigor in shrimp. The low amount of rigor usually observed in shrimp may be caused by the post-mortem basic tissue pH.

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## References

**Atwood, H. L.** (1972) Crustacean muscle. In: *The structure and function of muscle* (ed G. H. Bourne), 2nd edition, vol. 1, pp. 422–489. New York: Academic Press.

**Bailey, M. E., Fieger, E. A. & Novak, A. F.** (1956). Objective tests applicable to quality studies of ice-stored shrimp. *Food Res.*, **21**, 611.

**Bauer, B. A. & Eitenmiller, R. R.** (1974a) A study of some kinetic properties of partially purified *Penaeus setiferus* arylamidase. *J. Food Sci.*, **39**, 10–14.

**Bauer, B. A. & Eitenmiller, R. R.** (1974b) Muscle arylamidase activity of several marine species. *J. Fish. Res. Board Can.*, **31**, 445–448.

**Bethea, S. & Ambrose, M. E.** (1962) Comparison of pH, trimethylamine content and picric acid turbidity as indices of shrimp quality. *Commer. Fish. Rev.*, **24**(3), 7–10.

**Brown, A., Jr. & Patland, D.** (1974) Colour changes in the ovaries of penaeid shrimp as a determinant of their maturity. *Mar. Fish. Rev.*, **36**, 23.

**Bodnaryk, R. P., Burnet, P. C. J. & Koeppe, J. K.** (1974). On the metabolism of n-acetyldopamine in *Periplaneta americana. J. Insect Physiol.*, **20**, 911–923.

**Carroll, B. J., Reese, G. B. & Ward, B. Q.** (1968). Microbial study of iced shrimp: excerpts from the 1965 Iced-Shrimp Symposium. *US Department of the Interior Circ.* 284, 17 pp.

**Cobb, B. F. III, Alaniz, I. & Thompson, C. A. Jr.** (1973) Biochemical and microbial studies on shrimp: volatile nitrogen and amino nitrogen analysis. *J. Food Sci.*, **38**, 431–436.

**Cobb, B. F. III, Conte, F. S. & Edwards, M. A.** (1975) Free amino acids and osmo-regulation in penaeid shrimp. *J. Agric. Food. Chem.*, **23**, 1172–1174.

**Cobb, B. F. III & Vanderzant, C.** (1971) Biochemical changes in shrimp inoculated with *Pseudomonas, Bacillus* and a coryneform bacterium. *J Milk Food Technol.*, **34**, 533–540.

**Cobb, B. F. III & Vanderzant, C.** (1975) Development of a chemical test for shrimp quality. *J. Food Sci.*, **40**, 121–124.

**Cobb, B. F. III, Vanderzant, C. Hanna, M. O. & Yeh, C. S.** (1976) Effect of ice storage on microbiological and chemical changes in shrimp and melting ice in a model system. *J. Food Sci.*, **41**, 29–34.

**Cobb, B. F. III, Vanderzant, C. & Hyder, K.** (1974) Effect of ice storage upon the free amino acid contents of tails of white shrimp (*Penaeus setiferus*). *J. Agric. Food Chem.*, **22**, 1052–1055.

**DeVillez, E. J. & Buschlen, K.** (1967) Surveys of a tryptic digestive enzyme in various species of crustacea. *Comp. Biochem. Physiol.*, **22**, 541–546.

**Eitenmiller, R. R.** (1974) Cathepsin activity of *Penaeus setiferus* muscle. *J. Food Sci.*, **39**, 6–9.

**Flick, G. J. & Lovell, R. T.** (1972) Post-mortem biochemical changes in the muscle of Gulf shrimp, *Penaeus aztecus. J. Food Sci.*, **37**, 609–611.

**Gates, B. J. & Travis, J.** (1969) Isolation and comparative properties of shrimp trypsin. *Biochem.*, **8**, 4483–4489.

**Gates, B. J. & Travis, J.** (1973) Amino acid sequence in the vincinity of the reactive serine residue in shrimp trypsin. *Biochem. Biophys. Acta.*, **310**, 137–141.

**Green, M.** (1949a) Bacteriology of shrimp. I. Introduction and development of experimental procedures. *Food Res.*, **14**, 365.

**Green, M.** (1949b) Bacteriology of shrimp. II. Quantitative studies on freshly caught and iced shrimp. *Food Res.*, **14**, 372.

**Hashimoto, Y.** (1965) Taste-producing substances in marine products. In: *The technology of fish utilization* (ed. R. Kreuzer), pp. 57–60. Surrey: Fishing News (Books).

**Jones, N. R.** (1969) Significance of ribomonomucleotides and their metabolities. *J. Agric. Food Chem.*, **17**, 712–716.

**Katayama, T., Katama, T. & Chichester, C. O.** (1972) The biosynthesis of astaxanthin. VI. The carotenoids in the prawn *Penaeus japonicus* Bate (Part II). *Int. J. Biochem.*, **3**, 363–368.

**Koburger, J. A., Matthews, R. F. & McCullough, W. E.** (1974) Some observations on the heading of *Penaeus* shrimp. *Proc. Gulf and Caribbean Fish. Inst.*, **26**, 144.

**Lightner, D. V** (1973) Normal post-mortem changes in the brown shrimp, *Penaeus aztecus. Fish. Bull.*, **72**, 223.

**Neville, A. C.** (1975) *Biology of the arthropod cuticle*, pp. 116, 260. New York: Springer-Verlag.

**Rajendranathan Nair, M. & Bose, A. N.** (1965) Studies on post-mortem biochemical changes in prawns. In: *The technology of fish utilization* (ed. R. Kreuzer), p.68. Surrey: Fishing News (Books).

**Schoffeniels, E. & Gilles, R.** (1970) Osmo-regulation in aquatic arthropods. *Chem. Zool.*, **5**, 255.

**Stone, F. E.** (1971) Insine monophosphate (IMP) and hypoxanthine formation in three species of shrimp held on ice. *J. Milk Food Technol.*, **34**, 354–356.

**Vanderzant, C., Cobb, B. F. III., Thompson, C. A. Jnr. & Parker, J. C.** (1973) Microbial flora, chemical characteristics and shelf-life of four species of pond-reared shrimp. *J. Milk Food Technol.*, **36**, 443.

**Vanderzant, C. & Nickelson, R.** (1971) Comparison of extract-release volume, pH and agar plate count of shrimp. *J. Milk Food Technol.*, **34**, 115.

**Van Wormhoudt, A., Le Gal, Y. & Ceccaldi, H. J.** (1972) Sur l'activité des enzymes digestives au cours du cycle d'inermue chez *Palaemon serratus. C.R.*, **274**, (Serie D), 1337.

**Van Wormhoudt, A., Ceccaldi, H. J. & Le Gal, Y.** (1973) Variations aux differences saissons des activités enzymatiques digestives chez *Palaemon serratus*, ayant subi ou non l'ablation des pédonucules oculaires. *C.R.*, **277** (Serie D), 369–372.

**Williams, O. B., Rees, H. B. Jr. & Campbell, L. L. Jr.** (1952) The bacteriology of Gold Coast shrimp. I. Experimental procedures and quantitative results. *Texas J. Sci.*, **4**, 49–52.

**Wilaichon, W.** (1976) *Variation of shrimp texture with rigor mortis.* M. S. Thesis, Texas A & M University.

# Technological aspects of preservation and processing of edible shellfish

**C. George and M. R. Nair**
Central Institute of Fisheries Technology, India

## Summary

The influence of pre-process ice storage on the nutritive value and chemical constituents of cooked frozen mussel, *Mytilus edulis*, and crab, *Scylla serrata*, available on the west coast of India, has been studied. Large-scale trials carried out on the freezing of crab showed that the optimum cooking time was 15 minutes in boiling brine. The yield of body meat was 16 to 18% and that of claw meat approximately 20%. The thawing loss of frozen body meat was 6 to 12% and that of claw meat 6 to 8%. Studies on the storage life of frozen claw meat, both raw and cooked, indicated that the cooked product kept better than the raw frozen material; the frozen raw claw meat blackened during storage. In the case of mussel meat the optimum cooking time was 15 minutes and the yield 14 to 16%. The thawing loss in the product was 2 to 4% Shelf life was judged by chemical and organoleptic methods. The maximum frozen storage life was observed in pre-iced and cooked crab meat.

## Résumé

L'influence d'une préparation préalable par stockage dans la glace sur la valeur nutritive et les constituants chimiques de la moule congelée cuite, *Mytilus edulis*, et du crabe, *Scylla serrata*, que l'on trouve sur la côte ouest de l'Inde, a été étudié. Des essais sur une large échelle portant sur la congélation du crabe ont montré que le temps de cuisson optimum est de 15 minutes dans de la saumure bouillante. Le rendement de la chair du corps est de 16 à 18% et celui de la chair de la pince est d'environ 20%. La perte de décongélation de la chair du corps congelée est de 6 à 12% et celle de la chair de la pince est de 6 à 8%. Des études sur la durée de stockage de la chair de pince congelée à la fois crue et cuite ont indiqué que le produit cuit s'est conservé mieux que le produit cru congelé. La chair de la pince congelée crue a subi un noircissement durant le stockage. Dans le cas de chair de moule, le temps de cuisson optimum était de 15 minutes et le rendement de 14 à 16%. La perte de décongélation du produit était de 2 à 4%. La durée de conservation a été appréciée à l'aide de méthodes chimiques et organoleptiques. La durée de conservation maximum du produit congelé a été observée dans la chair de crabe précongelée et cuite.

## Resumen

Se ha estudiado la influencia del proceso previo de almacenamiento con hielo sobre el valor nutritivo y los componentes químicos de los mejillones cocidos y congelados, *Mytilus edulis*, y cangrejos, *Scylla serrata*, en la costa occidental de la India. En ensayos a gran escala llevados a cabo sobre la congelación de cangrejos se ha demostrado que el tiempo óptimo de cocción en agua salada es de 15 minutos. Del cuerpo se obtiene de un 16 al 18% de carne y de las patas alrededor de un 20%. En la descongelación se pierde del 6 al 12% de la carne del cuerpo y del 6 al 8% de la de las patas. Los estudios sobre la duración de almacenamiento de la carne de patas congeladas, tanto cruda como cocida, indican que el producto cocido se conserva mejor que el crudo congelado. La carne cruda de pata congelada se ennegreció durante el almacenamiento. En el caso de carne de mejillón, el tiempo óptimo de cocción fué de 15 minutos y la producción del 14 al 16%. La pérdidas por descongelación fueron del 2 al 4%. La duración de almacenamiento se juzgó por métodos químicos y organolépticos. La máxima duración de almacenamiento de la carne congelada se observó en la carne de cangrejo prerefrigerada con hielo y cocida.

## Introduction

Shellfish perform a vital role in India's economy and their popularity, both as a delicacy and as a high food value product, is increasing. There has been a steady increase in their utilization from 1958 to 1974, when landings rose from 1,508 to 16,663 tonnes. (CMFRI). Processing industries based on shellfish, such as crab and mussel, have come into existence since 1966 and the products have been exported to a number of countries. Although there is a large, world demand for canned crab meat, and frozen crab and mussel meats, India's contribution to the international market is insignificant partly due to lack of technological know-how.

Generally, consumers prefer cooked meat to raw material in the shell because the procedure involved in preparing and cooking the latter is troublesome. Furthermore, if the crabs are not cooked, shucking is difficult and this results in lower yields. Therefore, storage of frozen uncooked crab or crab meat is not satisfactory. This study is aimed at determining the processing conditions for the preparation of different types of frozen shellfish products and the storage characteristics of the frozen products processed from raw material previously held in ice.

## Materials and methods

Mussels (*Mytilus* sp.), collected from the Calicut area, were transported to the laboratory in a refrigerated van. Small lots were cooked in steam at atmospheric pressure for different lengths of time to determine the optimum cooking period as judged by appearance and flavour. Half of the lot was cooked for 15 minutes and allowed to cool (series A). This and the raw mussels (series B) were stored separately in insulated boxes in a ratio of 1:1 with ice. At intervals of one, three and five days, equal amounts were removed from A and B. The raw mussels were then cooked and immediately cooled (series B). The meat was separated from both, quick-frozen at –40°C with water as glaze and stored at –23°C. Fresh crabs (*Scylla serrata*), collected from a local source, were treated in a manner similar to the mussels; pre-freezing ice storage was continued up to 9 days and the frozen material was stored at –23°C. Raw and pre-cooked crab claws were frozen at –40°C and stored at –23°C.

The frozen stored materials were sampled at intervals, thawed at 4°C and analysed for physical, organoleptic and chemical characteristics. Total water extractable nitrogen (WEN), non-protein nitrogen (NPN) and free $\alpha$-amino nitrogen ($\alpha$-$NH_2N$) were used as chemical indices of quality. WEN and NPN were determined according to the methods given by Chinnamma *et al.*, 1970, and $\alpha$-$NH_2N$ by the method of Pope and Stevens (1939). The weight loss during freezing, storage and thawing was monitored by weighing before freezing and after thawing. The organolpetic scoring was made on the thawed material after cooking in 2% sodium chloride solution for five minutes and the quality was judged by a panel according to the following scoring system:

| | |
|---|---|
| (1) Characteristic colour, smell, texture and flavour | 10 marks |
| (2) Negligible loss of characteristic qualities | 7–9 marks |
| (3) Appreciable loss of characteristic qualities but still in an acceptable condition | 5–7 marks |
| (4) Change of colour, hardening of texture and loss of flavour | 3–5 marks |
| (5) Off-colour and stale flavour | 3–0 marks |

Samples scoring below 4 marks were regarded as unacceptable.

## Results and discussion

Optimum cooking conditions for whole crab and mussel were standardized and the results are given in Table 1; 15 minutes cooking was sufficient in both cases. The cooked yields were 18.41%, 19.72% and 15.00% and the thawed yields 91.8%, 92.6% and 97.7% for crab, crab claw and mussel respectively. Large-scale trials carried out in the laboratory on freezing of crab showed that the optimum cooking time was 15 minutes in boiling brine. The yield of body meat was 14 to 18% and that of claw meat approximately 20%. The thawing loss of frozen body meat was 6 to 12% and that of the claw meat was 6 to 8%.

TABLE 1. *Standard processing conditions*

| *Shellfish* | *Cooking time (min)* | *Cooked yield (%)* | *Appearance* | *Thawed yield (%)* |
|---|---|---|---|---|
| Crab: Body | 10 | 20.00 | Under cooked | |
| | 15 | 18.41 | Properly cooked | 91.8 |
| | 20 | 14.38 | Over cooked | |
| Claw | 15 | 19.72 | Properly cooked | 92.6 |
| Mussel | 10 | 18.20 | Under cooked | |
| | 15 | 15.00 | Properly cooked | 97.7 |
| | 20 | 11.50 | Over cooked | |

Table 2 gives organoleptic ratings of the cooked frozen material during storage. Cooked frozen crab and mussel behaved differently; frozen mussel of series A is better than that of series B while the series B crab is better than the series A crab. This may be because the leaching loss is higher in mussel due to the shell opening during the initial stages of ice storage; the outer shell of the crab prevents leaching loss to a greater extent. Shelf life in crab (iced for one day prior to freezing) is 42 weeks for series A samples and 46 weeks for series B samples. Discolouration and hardening are the limiting factors in the organoleptic acceptability. Discolouration increases with progressive pre-process ice storage and this change is marked in the case of meat after seven days, ice storage. Shelf life is related to pre-process ice storage since, as the length of ice storage advances, there is a decrease in frozen shelf life.

Table 3 shows the loss of WEN, NPN, $\alpha$-$NH_2$ N and thawed weight of cooked frozen crab (a) during freezing and subsequent storage up to 42 weeks and for cooked frozen mussel (b) up to 38 weeks. For crab the percentage losses of all these variables increased steadily during storage in both series although they were comparatively less in series B. Loss of WEN varied from 24.5 to 26.5% in one-day-iced material and nine-day-iced material respectively; it increased to 30.4 and 34.0% after 42 weeks of frozen storage.

Loss of characteristic flavour may be attributed to the loss of water-soluble, flavour-bearing constituents.

TABLE 2. *Organoleptic ratings of cooked frozen crab and mussel meat during storage*

| *Crab* | | | | | | | | | *Mussel* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Frozen storage (weeks)* | *Days in ice storage* *Series A* | | | | *Series B* | | | | *Frozen storage (weeks)* | *Days in ice storage* *Series A* | | | *Series B* | | |
| | *1* | *3* | *7* | *9* | *1* | *3* | *7* | *9* | | 1 | 3 | 5 | 1 | 3 | 5 |
| 1 | 10 | 9 | 8 | 8 | 10 | 9 | 8 | 7 | 1 | 8 | 8 | 7 | 9 | 8 | 7 |
| 4 | 10 | 9 | 8 | 7 | 10 | 9 | 7 | 6 | 4 | 8 | 7 | 6 | 9 | 7 | 7 |
| 12 | 9 | 8 | 6 | 7 | 10 | 8 | 5 | 5 | 16 | 7 | 6 | 5 | 5 | 3 | 5 |
| 18 | 9 | 8 | 5 | 5 | 9 | 8 | 5 | 5 | 28 | 6 | 5 | 5 | 2 | 2 | 2 |
| 24 | 7 | 5 | 3 | 2 | 8 | 7 | 4 | 4 | 38 | 5 | 4 | 3 | 1 | 1 | 0 |
| 34 | 6 | 4 | 2 | 1 | 7 | 5 | 2 | 2 | | | | | | | |
| 42 | 5 | 2 | 0 | 0 | 6 | 4 | 1 | 1 | | | | | | | |
| 46 | – | – | – | – | 5 | 3 | 1 | 0 | | | | | | | |

Series A: Cooked and iced
Series B: Iced and cooked

TABLE 3. *Percentage loss of nitrogenous constituents and thawed weight (expressed as a percentage of the original)*

*(a) Cooked frozen crab*

| *Days in ice* | *Frozen storage (weeks)* | *WEN* | | *NPN* | | *α-$NH_2$N* | | *Thawed weight* | |
|---|---|---|---|---|---|---|---|---|---|
| | | *A* | *B* | *A* | *B* | *A* | *B* | *A* | *B* |
| 1 | 1 | 24.5 | 20.8 | 18.4 | 19.1 | 19.7 | 17.0 | 11.4 | 8.8 |
| | 4 | 25.2 | 22.0 | 20.7 | 20.9 | 22.8 | 19.0 | 15.0 | 10.0 |
| | 12 | 25.8 | 30.0 | 26.2 | 25.3 | 28.3 | 22.0 | 19.4 | 15.0 |
| | 24 | 29.6 | 30.7 | 26.6 | 24.5 | 28.7 | 28.1 | 20.3 | 17.5 |
| | 42 | 30.4 | 33.5 | 31.0 | 31.0 | 30.7 | 30.5 | 23.9 | 19.3 |
| 3 | 1 | 25.1 | 24.1 | 19.8 | 24.2 | 23.7 | 20.5 | 14.5 | 9.8 |
| | 4 | 25.6 | 28.3 | 25.7 | 24.0 | 28.0 | 21.7 | 19.4 | 12.0 |
| | 12 | 28.2 | 34.5 | 25.1 | 29.7 | 28.4 | 26.7 | 23.0 | 14.8 |
| | 24 | 30.2 | 32.6 | 27.3 | 29.9 | 30.5 | 31.9 | 25.2 | 18.5 |
| | 42 | 29.2 | 33.8 | 29.1 | 31.9 | 33.4 | 29.8 | 26.0 | 19.3 |
| 7 | 1 | 25.8 | 26.1 | 25.1 | 24.9 | 24.1 | 23.5 | 16.9 | 11.1 |
| | 4 | 28.4 | 28.7 | 25.6 | 25.8 | 28.5 | 26.7 | 20.0 | 13.9 |
| | 12 | 33.4 | 31.0 | 33.4 | 30.2 | 30.5 | 31.9 | 23.0 | 17.5 |
| | 24 | 33.9 | 32.2 | 33.9 | 28.4 | 36.3 | 32.8 | 25.0 | 19.1 |
| | 42 | 32.8 | 35.1 | 34.5 | 31.9 | 37.6 | 34.5 | 30.4 | 22.7 |
| 9 | 1 | 26.5 | 32.5 | 26.5 | 34.5 | 27.5 | 29.5 | 17.9 | 13.9 |
| | 4 | 29.2 | 37.7 | 26.0 | 36.0 | 30.2 | 32.8 | 20.4 | 15.3 |
| | 12 | 30.3 | 40.8 | 28.5 | 39.7 | 35.3 | 39.1 | 25.2 | 17.5 |
| | 24 | 31.8 | 42.0 | 34.0 | 39.9 | 41.4 | 43.8 | 30.4 | 26.2 |
| | 42 | 34.0 | 41.6 | 41.2 | 40.7 | 43.5 | 43.5 | 33.5 | 28.7 |

A: Cooked and iced
B: Iced and cooked.

TABLE 3–*continued*
*(b) Cooked frozen mussel*

| *Days in ice* | *Frozen storage (weeks)* | *WEN* | | *NPN* | | *α–NH$_2$N* | | *Thawed weight* | |
|---|---|---|---|---|---|---|---|---|---|
| | | *A* | *B* | *A* | *B* | *A* | *B* | *A* | *B* |
| 1 | 1 | 9.3 | 10.8 | 8.5 | 9.8 | 11.3 | 13.0 | 2.5 | 2.9 |
| | 4 | 10.7 | 12.4 | 10.8 | 11.4 | 13.5 | 15.5 | 2.5 | 3.0 |
| | 16 | 11.3 | 13.1 | 8.3 | 13.7 | 14.7 | 15.7 | 2.5 | 4.5 |
| | 28 | 12.4 | 15.8 | 12.9 | 12.8 | 13.6 | 17.0 | 5.8 | 5.0 |
| | 38 | 15.0 | 17.4 | 15.9 | 14.5 | 15.0 | 18.5 | 6.2 | 5.9 |
| 3 | 1 | 10.8 | 11.2 | 9.8 | 10.9 | 13.5 | 15.0 | 4.8 | 4.6 |
| | 4 | 11.3 | 13.7 | 11.0 | 12.8 | 15.4 | 17.0 | 5.4 | 5.0 |
| | 16 | 11.9 | 13.7 | 12.8 | 14.0 | 16.7 | 16.8 | 6.3 | 6.6 |
| | 28 | 13.5 | 15.6 | 13.5 | 16.4 | 16.8 | 19.7 | 7.4 | 8.3 |
| | 38 | 14.9 | 17.2 | 17.0 | 16.8 | 17.9 | 19.3 | 8.3 | 9.1 |
| 5 | 1 | 11.0 | 11.9 | 10.5 | 13.1 | 15.0 | 16.5 | 5.1 | 5.4 |
| | 4 | 11.6 | 14.3 | 11.2 | 16.0 | 17.9 | 18.6 | 6.2 | 6.6 |
| | 16 | 12.7 | 15.3 | 12.7 | 17.2 | 18.1 | 19.8 | 7.4 | 8.7 |
| | 28 | 14.7 | 17.2 | 15.9 | 20.6 | 19.0 | 19.7 | 8.5 | 9.1 |
| | 38 | 16.5 | 20.3 | 16.5 | 26.7 | 19.8 | 21.2 | 9.0 | 12.0 |

A: Cooked and iced.
B: Iced and cooked

TABLE 4. *Storage characteristics of raw and pre-cooked crab claws*

| *Frozen storage (weeks)* | *Colour* | | *Smell* | | *Texture* | | *Flavour* | |
|---|---|---|---|---|---|---|---|---|
| | *A* | *B* | *A* | *B* | *A* | *B* | *A* | *B* |
| <1 | Charcoal grey | Pink | Good | Loss of some smell | Good | Good | Charcoal flavour | Good-fair |
| 8 | Brownish | Pink | Fair | Fair | Good | Slightly tough | Good | Good-fair |
| 12 | Slight blackening | Pink | Fair | Fair | Granular | Fibrillar | Good | Good-fair |
| 20 | Black | Pink | Fair-poor | Fair-poor | Granular | Granular | Fair | Fair |
| 32 | Black | Pink | Fair-poor | Fair-poor | Granular | Granular | Fair-poor | Fair-poor |

A: Raw claw
B: Pre-cooked claw

From Table 3 (b), it is clear that the nutritional loss, as well as the weight loss, of cooked frozen mussel was less during subsequent frozen storage when compared to crab. Loss of WEN was in the range of 9.3 to 16.5%, NPN 8.5 to 16.5%, α-NH$_2$N 11.3 to 19.8% and weight 2.5 to 9.0% in series A samples; for series B samples, the losses were 10.8 to 20.3%, 9.8 to 26.7%, 13.0 to 21.2% and 2.9 to 12.0% for WEN, NPN, α–NH$_2$N and weight respectively. The losses were comparatively more in series B samples and this correlates with the organoleptic score.

Table 4 gives an account of the storage characteristics of raw frozen and cooked frozen claws, discolouration is the major factor which limits shelf life. During storage, the pre-cooked claws are of better quality and a shelf life of about 32 weeks is observed, discolouration is observed in raw frozen claws after only 8 weeks.

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## References

**Chinnamma, P. L., Choudhury, D. R. & Pillair, V. K.** (1970) *Fish Technol.*, 7 (2), 137.

**CMFRI.** Reports of the Central Marine Fisheries Research Institute, Cochin, India.

**Marine Products Export Promotion Council** (1973) Statistics of the marine products exports.

**Pope, C. G. & Stevens, M. F.** (1939) Determination of amino nitrogen using a copper method. *Biochem.* J., 33, 1070–1077.

# Chilling of langostinos (*Pleuroncodes monodon*): some observations on organoleptic quality and yield

**H. H Huss**
Ministry of Fisheries, Denmark
and
**I. Asenjo**
Instituto de Fomento Pesquero, Chile

## Summary

A rich and valuable resouce of langostinos is found in the waters off the Chilean coast. In a series of experiments, in which ice, air or seawater was used as the chilling medium, the effect of holding the raw materials at various temperatures was studied. Best organoleptic quality and yield (up to 13%) were obtained by processing live langostinos. A high survival rate was observed where the animals were held at 5–6°C. Rapid chilling to low temperatures near zero causes death of the langostinos and in these cases, and also when the langostinos have died for some other reason, it is essential to maintain a low storage temperature. At storage temperatures of 5–6°C or lower the loss in yield was about 1–2% per day of storage (approximately one-fifth of the yield).

## Résumé

Des ressources abondantes et de grande valeur en langoustines se trouvent dans les eaux au large de la côte chilienne. Dans une série d'expérimentations dans lesquelles la glace, l'air ou l'eau de mer ont été utilisés comme moyens de réfrigération, l'effet de maintenir les produits crus à des températures diverses a été étudié. La meilleure qualité organoleptique et le meilleur rendement (jusqu'à 13%) ont été obtenus par la préparation de langoustines vivantes. Un taux élevé de survie a été observé lorsque les animaux étaient gardés à une température de 5 à 6°C. Un refroidissement rapide à de basses températures au voisinage de zéro a causé la mort des langoustines et dans ces cas, et également lorsque les langoustines étaient mortes pour quelque autre raison, il était essentiel de maintenir un bas niveau de température. A des températures de stockage de 5 à 6°C ou plus basses, la perte de rendement a été d'environ 1 à 2% par jour de stockage (approximativement un cinquième du rendement)

## Resumen

Las aguas de la costa chilena son una importante fuente de langostinos. En una serie de experimentos, utilizando como medio de refrigeración hielo, aire o agua de mar, se ha estudiado el efecto de la conservación de la materia prima a distintas temperaturas. La mejor calidad organoléptica y producción (hasta un 13%) se obtuvo elaborando los langostinos vivos. Se observó un porcentaje alto de supervivencia cuando los animales se mantenían a 5–6°C. El enfriamiento rápido a bajas temperaturas cercanas a cero causó la muerte de los langostinos y en estos casos, así como cuando los langostinos habían muerto por alguna otra razón, fue esencial mantener una baja temperatura de almacenamiento. A temperaturas de almacenamiento de 5–6°C o inferiores, la pérdida de producción fue de alrededor de 1–2% por día de almacenamiento (approximadamente un quinto de la producción).

## Introduction

The name langostino, in Chile, refers to two distinct species of crustaceans, the langostino amarillo (*Cervimunida johni*) and the langostino colorado (*Pleuroncodes monodon*); only the latter is today of any commercial importance. It should be noted that in Peru and Ecuador the term 'langostino' is used for some very large shrimp species quite different from the Chilean langostino. Recent biological investigations have confirmed a substantial resource in the Gulf of Mexico of a 'pelagic crab' species (*Pleuroncodes planiples*) very similar to the langostinos caught in Chilean waters (Longhurst, 1968).

The langostino in Chile is found in the coastal waters (100–400m depth) which are kept cool (11–14°C) all the year round by the Humboldt current. The animals moult in the warm summer months creating some special technological problems. The length of cephalothorax varies, most commercial samples being 30–45 mm. The langostinos are caught by bottom trawling and the average catch is approximately 1 ton per hour. Once on board the catch is sorted, the fish being removed. On short voyages lasting only one day no chilling is applied but on longer trips (two to three days) the catch is mixed with ice (1:4) and stored in bulk in the hold. On landing the langostinos are processed into cooked peeled tails, packed in polyethylene bags and then plate-frozen.

## Storage experiments

Due to poor organoleptic quality of commercial samples and low industrial yield (3–7% depending on the season), experimental work to assess various chilling methods was initiated.

### *Influence of storage time and temperature on survival*

It is characteristic of littoral organisms such as molluscs and crustaceans that they can remain alive out of water for extended periods. The survival time depends on temperature; it was found that +6°C is the optimum temperature for keeping abalone alive out of water (James and Olley, 1970). Living animal tissue is sterile and no deteriorative changes take place until organic death. Conditions just prior to death may influence the rate of deterioration but, generally, processing of live raw material offers the best possibility of good organoleptic quality in the final product.

Observations on survival were made in a number of experiments holding langostinos at various temperatures in air, ice or sea water. It was noted that very low temperatures near 0°C or direct contact with ice quickly killed animals whether the cooling medium was ice, cold air or sea water. On the other hand, 100% survival was achieved when the langostinos were stored in chilled sea water (CSW) at 7–8°C and the tanks were equipped with air circulation. A considerable survival rate was also evident during storage in air at 5–8°C. In this group 10–20% of the animals were still alive after 2–3 days of storage.

### *Influence of storage time and temperature on yield*

In a number of experiments, the yield of peeled meat was determined after storage of the raw material for up to 3 days at various temperatures. Experimental material was collected on board commercial trawlers, sorted into 5 kg lots and stored in air, ice or sea water at temperatures from –1 to +20°C. On the first, second and third day after capture, one lot from each group was removed, cooked and peeled in one of the processing factories, and the yield of peeled meat was calculated on the original 5 kg of raw material. The conditions of the raw material and the results of the investigations are shown in Table 1. In Figure 1 the results are pooled into groups according to the storage temperature.

It is a general observation that, not surprisingly, the highest yields (10.5–13.5%) are obtained when fresh (one day old) raw material is used but this applies, surprisingly, to holding temperatures up to 10–14°C. If the langostinos are kept at temperatures higher than 15°C the yield of peeled meat (also from fresh raw material) decreases substantially. Processing of langostinos after further storage of the raw material for up to 3 days gives decreasing yields, depending on storage time and temperature. When the raw material is stored at temperatures below +8°C the yield of peeled meat decreases by approxi

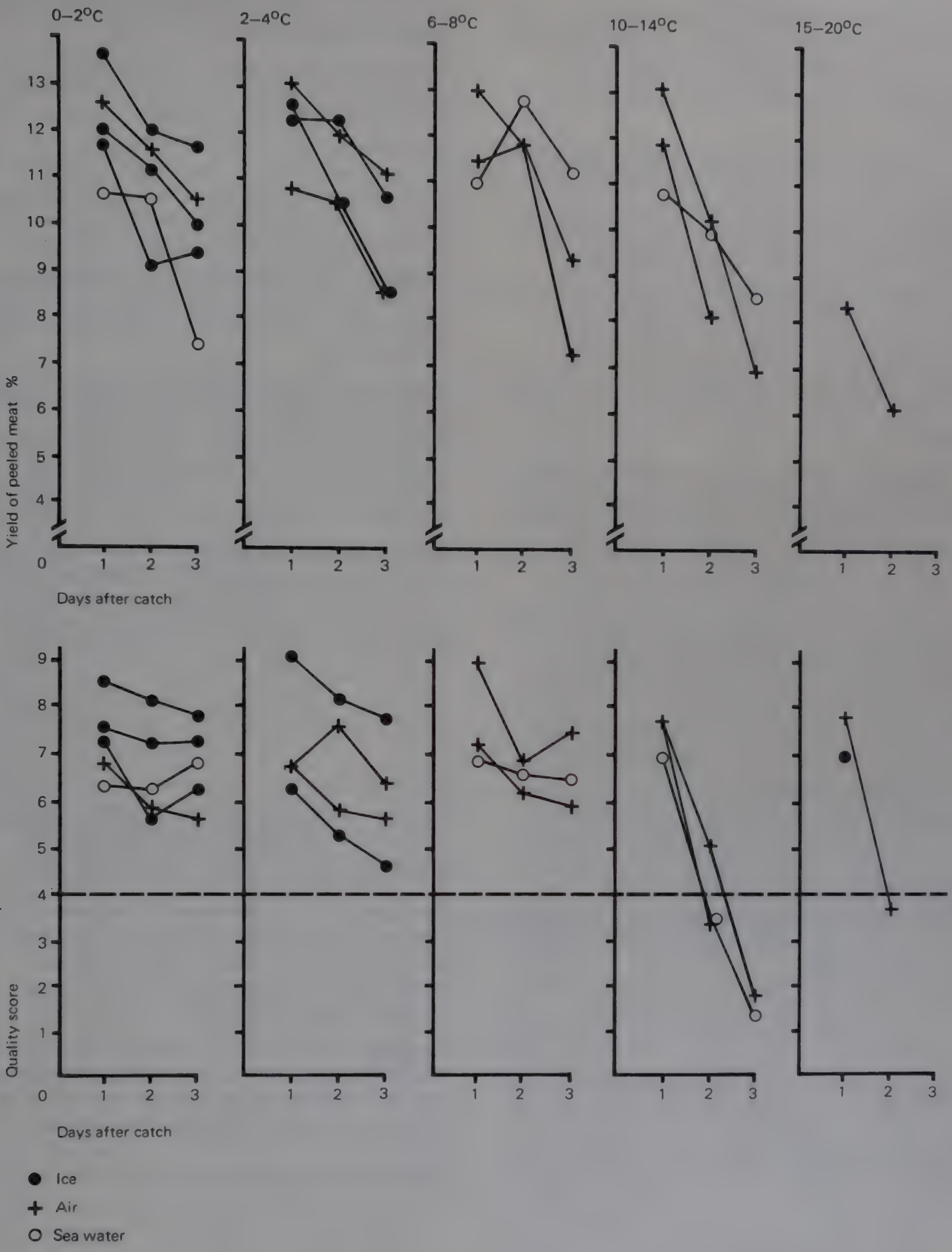
TABLE 1. *Storage conditions, yield and quality score of langostinos*

| *Storage temperature °C* | *Conditions of langostinos* | *Cooling medium* | *Circulation air/water* | *Yield of peeled meat (%)* | | | *Quality score** | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Days after capture* | | | *Days after capture* | | |
| | | | | *1* | *2* | *3* | *1* | *2* | *3* |
| 15–20 | Live | Air | No | 8.4 | 6.0 | – | 7.9 | 3.8 | – |
| 12–14 | Dead | Air | No | 11.8 | 8.0 | – | 7.8 | 3.4 | – |
| 10–13 | Live and dead | Air | No | 13.0 | 10.1 | 6.9 | 7.6 | 5.1 | 1.8 |
| 9.5–11.5 | Live and dead | Sea water | Yes | 10.7 | 9.8 | 8.5 | 7.0 | 3.5 | 1.3 |
| 7.7–8 | Live | Air | Yes | 11.4 | 11.8 | 9.2 | 9.0 | 6.9 | 7.5 |
| 5–8 | Live and dead | Sea water | Yes | 10.9 | 12.7 | 11.2 | 7.0 | 6.6 | 6.5 |
| 6.5–8.5 | Live and dead | Air | Yes | 13.0 | 11.7 | 7.1 | 7.2 | 6.1 | 5.9 |
| 1.0–3.5 | Live and dead | Air | Yes | 10.7 | 10.5 | 8.5 | 6.4 | 7.5 | 6.4 |
| 1.0–4.0 | Live | Ice | No | 12.2 | 12.2 | 10.6 | 9.1 | 8.2 | 7.9 |
| 0.0–4.0 | Live and dead | Ice | No | 12.5 | 10.4 | 8.5 | 6.3 | 5.4 | 4.6 |
| 1.0–4.0 | Dead | Air | Yes | 13.0 | 12.0 | 11.0 | 6.8 | 7.7 | 6.4 |
| 1.0–2.5 | Dead | Air | Yes | 12.6 | 11.6 | 10.4 | 6.8 | 5.9 | 5.6 |
| 0.0–2.2 | Live | Ice | No | 12.0 | 11.2 | 10.0 | 8.6 | 8.2 | 7.9 |
| 1.0–2.0 | Dead | Ice | No | 13.6 | 12.0 | 11.6 | 7.6 | 7.3 | 7.3 |
| –1.0–2.0 | Dead | Ice | Yes | 11.7 | 9.1 | 9.4 | 7.3 | 5.7 | 6.2 |
| –0.0–1.9 | Dead | Sea water | Yes | 10.6 | 10.5 | 7.3 | 6.4 | 6.2 | 6.9 |

*Quality was assessed by a panel of eight. A hedonic scale was used in the assessment. A score of 10 represents the ideal sample, 8 good quality and 6 fair quality. A score of 4 is given to the 'just acceptable' sample and 0 is the very poor quality.

**Figure 1**

**Yield of peeled meat and organoleptic quality of cooked, peeled, pasteurized, frozen and thawed langostinos after storage of raw material in ice, air or seawater at various temperatures up to 3 days.**



mately 1–2% (up to 1/5 the yield) per day of storage, while at holding temperatures higher than +8°C the yield decreases by about 2–4% (up to 2/5 of the yield) per day of storage.

No significant difference in yield of peeled meat was observed after storage of the raw material in the various cooling media (air, ice or sea water). Large weight changes were noted in the raw material but, since these changes were mostly related to the cephalothorax, they had very little influence on the yield of peeled meat.

*Influence of storage time and temperature on quality*

1. *Organoleptic quality.* In one series of experiments the raw material was held at various temperatures, using air, ice or chilled sea water as the cooling medium, and was

processed in one of the existing processing factories without interfering with normal practice. Immediately after cooking, peeling, measurement of yield, dipping and pasteurization the meat was frozen in the plate freezer, packed in polyethylene bags (compressor to –10 to –30°C for 2 hours) and stored at –25°C until organoleptic assessment. Organoleptic assessment of the thawed tail meat was carried out by a panel of eight members.

The results of the organoleptic assessments are included in Table 1 and are also shown graphically in Figure 1. It appears that the raw material can be stored for one day at temperatures up to 10–14°C without the organoleptic quality of the final product being seriously affected. However, if the raw material is stored for more than one day at 9–10°C the final product is of inferior or unacceptable quality. Therefore, to produce a good quality product from raw material which has been stored for more than one day, chilling to 5–8°C or lower is necessary; the actual chilling method being of minor importance.

2. *Physical and chemical changes.* In addition to organoleptic assessment, the quality of the experimental material was evaluated by physical and chemical methods. The pH of the raw tail meat was measured by a pH meter on a macerate of meat and distilled water. One day after capture, the pH in all samples was found to be 6.2–6.5 irrespective of the storage temperature. After two days' storage at temperatures above 8–10°C the pH rose to 7.1–7.2 while only a small rise in pH to 6.6–6.8 was noted in samples stored for three days at lower temperatures. No significant difference in muscle pH was seen in langostinos stored in ice, air or chilled sea water.

No development of volatile bases was recorded in any sample stored for up to three days at low temperatures ($<8$°C) the TVB content in all cases being low ($<15$ mg N/100g). However, in two samples stored at high ambient temperatures (15–20°C) for two days, large amounts of volatile bases developed (32 and 76 mg N/100g) and the organoleptic quality of the samples was below the limit of acceptability.

## Conclusions

Best quality and yield of final product are obtained by processing live langostinos. Reduced towing time, especially when large catches are expected, is necessary in order to obtain a large percentage of live langostinos on deck. Careful sorting is necessary to avoid killing the animals by rough handling and it is recommended that bulk storage on board be replaced by some form of container or box storage.

As far as chilling is concerned, it was demonstrated that good organoleptic quality and high yield ($>10.5\%$ of peeled meat) can be obtained when the raw material is kept at temperatures up to 15°C for one day only. At higher temperatures, or if storage for more than one day is required, some chilling is necessary. A storage temperature of 5–6°C or lower is recommended to ensure good organoleptic quality and high yields ($>9\%$ of peeled meat) after 3 days of storage. The chilling method appears to be of minor importance since equally good results were obtained using cold air, ice or chilled sea-water as the cooling medium.

Rapid chilling to low temperatures near zero causes death of the langostinos and in these cases, and also when the langostinos have died for some other reason, it is essential to maintain a low storage temperature. At storage temperatures of 5–6°C or lower, the loss in yield is about 1–2% per day of storage (approximately 1/5 of the yield).

High muscle pH ($>7.0$) and the development of volatile bases ($>20$ mg%) are associated with spoilage of the raw material. However, low organoleptic quality may be found in samples of the final product with low levels of pH and TVB.

## References

**James, D. G. & J. Olley** (1974) The abalone industry in Australia. In: *Fishery products* (ed. R. Kreuzer), pp.238–242. Surrey: Fishing News (Books), 462pp.

**Mistakidis, M. N. & G. Henriques** (1966) Informe sobre investigaciones exploratorias de langostinos y camarones con la zona de Constitucion – Isla Mocha, Octubre – Noviembre 1965. *Instituto de Fomento Pesquero, Santiago, Publicacion* No. 16.

**Longhurst, A. R.** (1968) The biology of mass occurences of galatheid crustaceans and their utilization as a fisheries resource. In: *FAO Fish. Rep.* No. 57, Proc. World Sci. Conf. on the biology and culture of shrimps and prawns, Mexico City, 12–21 June 1967. Vol. 2 Review, regional summary and experience papers, pp.95–110, (587pp).

# Discussion

In this session there was one discussion after the four presentation papers and one after the moderator's review.

## Papers 1 to 4

Due to the number of lead papers in this session, the schedule was extremely tight and because one of the papers was rather lengthy this discussion period was comparatively short. It was, nonetheless, quite lively and could, like most of the other discussions, have continued for longer. A number of comments were made on the papers and considerable interest was expressed in the bacteriological aspects of shellfish products, particularly with regard to import regulations.

At **Peterkin's** request, **Gordon** spoke briefly of two products which have been developed in Guyana to make use of under utilized species of fish in the shrimp by-catch. The salt fish powder, similar to the Canadian product which is the subject of the paper by **Bligh** and already mentioned in Session 5, and the fish jam, prepared from deodorized fish, fruit juice, flavour concentrate and pectin both, show considerable promise.

Referring to a slide shown by **Amla** giving numbers and capacities of shrimp freezing plants and cold stores, **Levy** said that, from a quick calculation, he assumed the heading 'tons per day' should refer only to the freezing plants. He also asked the current method of freezing. **Amla** agreed on the first point and said that shrimp are plate frozen.

**Huss** noted that the importance of quality had been emphasized in the paper by **Young** and he suggested that a solution to the problem of cooked shellfish may be pasteurization of the final product in a plastic bag; this method proved very successful in Chile. **Young** commented that their aim is for products which taste as near 'fresh' as possible; sterilization methods unfortunately tend to destroy both flavour and texture. To this **Cann** added that in-the-bag pasteurization is suitable for small packs only, but he also pointed out that re-cooking just before final processing is practised in some countries.

Two questions from **Foo** changed the topic for discussion. To his first question on the size and method of pricing prawns for the Japanese market, **Amla** replied that they export mainly large sizes to Japan and the price is freely negotiable, based on the current world situation. **Peterkin** noted that the Japanese wanted sizes of 10–35 or 36–40/lb; the price is negotiated upwards on the current green sheet price and cold storage holdings in USA and Japan. The second question on quality/health regulations for frozen, cooked and peeled prawns imported into UK and Europe was taken up by **Cann** and **D. T. Jones.** Recommended bacteriological standards or guidelines for total counts and specific pathogens are laid down in many countries including the UK. Based on these guidelines, which are agreed by the health authorities and the industry, frozen, cooked prawns for import to UK may, said **D. T. Jones**, be accepted conditionally or unconditionally, rejected or re-exported. Thus, if total counts are $< 10^5/_g$ the prawns are accepted, if counts are $10^5$–$10^6$, a warning is given and above $10^6$ they are re-exported. If *Staphylococcus aureus* is present at $> 1000$/g the prawns are destroyed but a tolerance of one sample in five with $< 10{,}000$/g is permitted. There is no standard for *Vibrio parahaemolyticus* since its pathogenicity is not accurately known.

Commenting on the paper by **Amla** and **Sen** and the paper by **Kuriyan** in Session 5, **Hall** said that the two Indian Institutes (Central Institute of Fisheries Technology (CIFT) and the Central Food Technological Research Institute (CFTRI)) seem to be heavily involved in working towards the export trade and he wondered to what extent it is foreseen that these Institutes will be involved in work for the home and export markets. In reply, the Chairman stated that in his paper he tended to concentrate only on products with a potential for export; considerable work is however devoted to the home market (some examples are reported in other CIFT papers, for review by the moderator, in a number of sessions of this Conference). **Amla** agreed and added that CFTRI is also carrying out investigations specifically related to the needs of the home market; he pointed out that valuable foreign exchange earned from the export of high value fish products would allow the purchase of cheaper nutritious grains and legumes which are easily distributed and readily acceptable.

Finally **Watkin**, referring to the paper by **Cann**, drew attention to the Aberdeen typhoid outbreak of 1958, which was directly attributable to oysters. He was concerned about 'kitchen contamination' and defended the bacterial examination of raw products so as to avoid the introduction of pathogens and the possible cross contamination of cooked and uncooked products which will not be further heated before consumption: there is however a problem of mixing standards for raw and pre-cooked products. **Cann** agreed that oysters should be examined; he felt that standards for certain species need not necessarily apply to other species.

### Papers reviewed by the moderator

In this period, discussion continued on the general theme of microbial quality of shrimps. There were no questions or comments directed specifically at any of the moderated papers. This discussion was also fairly short.

After the moderator's review **Huss** spoke on his paper emphasizing two points but added no new information and **Merican** showed several slides illustrating various problems associated with quality problems which arise in the Malaysian prawn industry. **Aribisala** then spoke on various aspects of the shrimp industry in Nigeria.

The discussion was opened by **Iyer** commenting that work carried out at his Institute has shown the microbial quality of processed shrimp to be affected by season. In the summer, faecal streptococci counts are very high and in the monsoon, *Escherichia coli* counts are high. This situation is likely to hold for other tropical countries and he felt, therefore, that all processors must pay particular attention to hygiene in these seasons.

In response to **Steinberg's** query on the differences in spoilage characteristics of freshwater and marine shrimps and prawns, **Young** commented that there have been some problems in the UK with freshwater prawns. He suspected this was related to poor handling but may also be due to river pollution.

Following on, **Kambikambi** asked who is responsible for consignments of prawns which are rejected on arrival at the port but were decreed fit for consumption by the producer. In reply, **D. T. Jones** stated that where discrepancies such as this do occur, it is likely that there is a difference in the method of examination at each end of the export chain. The Chairman added that problems can occur during shipping; he knew of an instance when defrosting occurred through a fault in the ship's freezer. **Billy** mentioned that it is the owner who bears the responsibility for his consignment and **Moal** commented that it is good therefore that we have insurance cover.

**Garm** then drew the attention of the meeting to the FAO Code of Practice for shrimps/prawns; Codex Standards for prawn will be finalized in the near future. As a final comment, **Billy** mentioned that a recent publication, *How to export fishery products to the USA*, which contains all Federal requirements for potential exporters, may be of interest to some delegates.

# Session 8
## Fisheries development

**Friday 9th July**
**Morning**

Chairman
W. Krone
Department of Fisheries
FAO

Moderator
R. C. Cole
Tropical Products Institute
UK

Rapporteur
P. Hjul
Fishing News International
UK

# Les problèmes rencontrés dans la modernisation de la pêche traditionnelle dans les pays en développement*

**R. A. Moal**
Société Centrale pour l'Equipment du Territoire
et
**Y. Lagoin**
Ministère de l'Agriculture, France

## Summary

The paper examines the obstacles associated with the exploitation of coastal fisheries in developing countries and considers possible improvements, which are considered not only in terms of increased productivity but also the reduction of wastage. Particular emphasis is placed upon the benefits which can be obtained through improved methods, training and the effective dissemination of information.

In tropical waters, with some exceptions, there is little possibility of increasing catches by unified fishing. On the other hand, there is considerable scope for reducing the losses which occur between catching and consumption.

The paper then examines the measures which could be taken to improve handling, processing and marketing conditions in developing countries. These measures relate more to the control of the various factors in the distribution network than to the need for large capital investment.

## Résumé

Après avoir examiné les conditions techniques d'exploitation des eaux côtières dans les pays en voie de développement et défini les différents obstacles à l'accroissement de leur productivité, il a été examiné les améliorations possible que permet d'espérer l'évolution de la technologie mondiale. Ces améliorations sont décrites dans l'optique non seulement de l'accroissement de la productivité mais aussi d'une meilleure rentabilité de la production par une réduction de ses pertes. Il a particulièrement été insisté, sur tout ce qu'une bonne diffusion de l'information, un encadrement important et l'amélioration des pratiques peuvent apporter dans ce domaine.

Dans les eaux tropicales, à quelques exceptions près, le niveau des ressources nous laisse guère espérer la possibilité importante d'accroissement du rendement par unité d'effort de pêche. Par contre, de grands espoirs sont permis s'il intervient une réduction sensible dès pertes qui se produisent des la capture jusq'au consommateur.

Les auteurs ont donc examiné les mesures qui pourraient être prises pour améliorer les conditions de manipulation, de traitement et de commercialisation du poisson dans les pays en voie de développement. Ces mesures portent plus sur la formation et le contrôle de l'activité des différents argents intervenant dans les circuits de distribution que sur le recours à des investissements importants.

## Resumen

El artículo examina los obstáculos que se presentan a la explotación de pesquerías costeras de los países en vías de desarrollo y considera las mejoras posible. La mejoras se consideran no solamente bajo el punto de vista de incremento de productividad sino también de reducción de pérdidas de productos. Se concede particular importancia a los beneficios que pueden obtenerse mediante la utilización de métodos más avanzados, adiestramiento del personal y una difusión efectiva de la información.

En las aguas tropicales, con algunas excepciones, hay pocas posibilidades de incrementar la pesca por sistemas unificados. Por otra parte, hay una considerable posibilidad de reducir las pérdidas que ocurren entre la pesca y el consumo.

El artículo examina después las medidas que podrán tomarse para mejorar las condiciones de manipulación, elaboración y comercialización en los países en vías de de desarrollo. Estas medidas se refieren más al control de los distintos factores de la red de distribución que a la necesidad de grandes inversiones de capital.

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*An English translation of this paper is available from the Tropical Products Institute

Comme dans les pays industrialisés, l'amélioration de la manipulation, de la transformation et de la commercialisation des produits de la pêche est conditionnée par les modalités d'obtention de ces produits. Denrées hautement périssables, leur fragilité est accrue par l'environnement généralement défavorable à leur conservation (température et hygrométrie simultanément élevées, abondance d'insectes prédateurs etc). Plus encore que dans les pays industrialisés, ce sont essentiellement les pêcheurs qui supportent les conséquences de cette situation. C'est donc avant toute autre intervention, sur les conditions d'exercice de leur profession que doit porter l'attention de tous ceux qui officiellement ou non, veulent développer la consommation des produits de la mer, d'une part sur les conditions matérielles en augmentant la productivité, en améliorant le confort et en humanisant le travail à bord, d'autre part sur les conditions de conservation du produit de ce travail, en cherchant à éliminer toutes les causes de son altération.

## La pêche artisanale traditionelle

### *L'embarcation*

Contrairement à ce qu'elle est devenue dans les pays hautement industrialisés, sa fonction transport du produit est encore secondaire par rapport à son rôle dans l'accroissement de la production.

Les plus simples sont les radeaux (jangadas brésiliennes, radeaux yéménites, catamarans ceylanais); l'absence de matériaux de base, grands arbres, n'a pas permis que ces embarcations soient plus perfectionnées. Mues à la pagaie ou à la voile, elles ne remontent pas au vent. Leur autonomie est limitée par le temps de la marée (renversement de vent). Même avec une propulsion mécanique (moteurs hors bord) ces embarcations représentent un terme d'évolution.

Il en est de même pour la pirogue, qui est un tronc équarri, plus ou moins bien travaillé et aménagé (monoxyle avec parfois des renforts sur les flancs, des éperons, des protections supplémentaires contre le submersion, l'adjonction de balanciers pour accroître la vitesse etc). Sa taille et sa forme sont fonction de la nature des arbres disponibles, de l'état de la mer (barre), et de la distance et de la localisation des lieux de pêche.

Son mode de locomotion est fonction:

- des condtions météorologiques (limitation et souvent impossibilité en zone d'alizés et de mousson)
- de l'état de la mer
- des distances des lieux de pêche : ceux-ci ne peuvent en aucun cas être situés au-delà d'un point qui peut être atteint par la pirogue mue par le vent de terre qui souffle en fonction de l'heure et de la périodicité de la marée.

La pirogue est régulièrement mue à la pagaide, souvent à la voile, de plus en plus fréguemment grâce à un moteur hors bord.

Les limites des embarcations traditionnelles, qui interdisent toute évolution dans le sens d'un accroissement de la qualité des produits débarqués, sont:

(1) L'état de la mer, le faible franc-bord et l'instabilité sont des facteurs tres limitants.

(2) Les migrations saisonnières des espèces particulièrement pélagiques qui rendent difficiles toute standardisation des engins, tout accroissement de leur productivité de même que l'industrialisation de la conservation ou de la transformation des captures.

(3) Le rayon d'action. Si la pirogue n'est pas motorisée, c'est essentiellement la durée du vent de terre ou de mer lors de chaque marée qui le détermine. Si elle est motorisée, c'est la durée du jour puisqu'il parait difficile et dangereux que sur une telle embarcation un ou des pêcheurs passent une nuit en mer.

(4) La disponibilité de troncs de qualité et de taille suffisantes. Celle-ci est de plus en plus difficile à obtenir avec la mise en coupe réglée des forêts tropicales.

(5) La nature et l'importance des engins embarqués: les arts traînants ne peuvent être utilisés, et les autres engins sont limités en taille et en nombre par la capacité de la pirogue.

(6) La protection correcte des captures, rendue très difficile par le volume réduit et la disposition des emplacements, ainsi que par l'absence d'énergie disponible (et donc de froid) pour leur stockage à bord.

La pirogue ne peut plus guère évoleur dans sa conception. Elle est donc progressivement condamnée. De ce fait, la pêche traditionnelle de subsistance ou commercialisée devrait l'être avec elle puisqu'elle ne permet pas une augmentation de la productivite du pêcheur, seule susceptible de compenser un accroissement beaucoup plus rapide des coûts d'exploitation que des prix de vente unitaire des captures. Le développement de la pêche traditionnelle ne peut venir que de la substitution à la pirogue d'un nouveau type d'embarcation.

### *Les engins de pêche*

Ils sont variés: passifs (lignes, palangres, filets maillants, casiers, etc) et actifs (filets encerclants, coulissants ou nou, éperviers, etc). Là encore en matière de pêche traditionnelle, on atteint rapidement une limite dans leur variété, leur emploi ou leur productivité.

Cette limite est la conséquence:

- de la capacité réduite de transport de la pirogue
- de sa forme et de sa vitesse (interdiction des arts trainants et de certains moyens actifs)
- de la profondeur de la zone de pêche, puisque la pirogue ne permet que difficlement la mécanisation du hissage des engins à l'eau
- de la température de l'eau qui nuit à la conservation des animaux capturés, séjournant morts dans l'eau et de ce fait empêche l'utilisation de la plupart des engins de captures dits posés (palangres etc).

### *Les centres de pêche traditionnelle*

La motivation principale étant avant tout d'assurer leur subsistance, les pêcheurs traditionnels, dans les pays en voie de développement se sont implantés le long des côtes en fonction essentiellement de deux critéres: les ressources accessibles par les moyens dont ils pouvaient disposer et la disponibilité d'eau douce près de la côte.

La commercialisation des produits n'ayant jamais été la finalité de leur activité, la dispersion des points d'implantation, reliés entre eux par des pistes essentiellement praticables à pied suffisaient à leurs besoins.

Obstacles à la modernisation de la production liés a l'implantation des villages de pêcheurs sont:

(1) Enclavement: la modernisation du réseau routier n'a que très rarement tenu compte de l'implantation des villages de pêcheurs, puisque la rentabilité économique de l'investissement n'était en aucune facon conditionnée par eux.

(2) Absence d'énergie: elle est la conséquence de l'enclavement et elle a pour conséquence l'absence de moyens de stockage et de transformation modernes.

(3) Nature du traitement traditionnel des produits: il est exclusivement concu pour éviter la perte des captures. Il n'apporte aucune valeur ajoutée et les couts de son application (main d'oeuvre, combustible, etc) ne sont jamais comptabilisés.

(4) Difficulté d'évacuation des captures en l'état: l'absence de voies de communications rend difficile l'emploi de moyens modernes seuls acceptables du fait de la fragilité des produits de la mer, en l'état. De plus, généralement il y a de grandes distorsions entre le volume des frêts aller et retour.

(5) Impossibilité quasi générale d'application de règles d'hygiène sommaire. Ceci est la conséquence de l'isolement des villages, du très faible taux de scolarité des habitants, de la non pénétration de l'information, et de la non valorisation des productions non commercialisées. Tous ces faits conduisent à l'indifférence des populations à l'égard de ces problèmes.

Tous les obstacles ci-dessus énumérés conduisent à une méfiance des organismes de financement publics ou privés à l'égard de la modernisation des circuits de distribution des produits de la pêche traditionnelle. Généralement le montant des investissements d'infrastructures nécessaires est hors de proportion avec les ratios de rentabilité attendus. Il en résulte un isolement encore plus grand de la côte et des populations qui y sont liées, au fur et à mesure du développement de l'arrière pays. Le désenclavement ne peut venir que d'une intervention motivée par une activité autre. Lorsque celle-ci est industrielle, elle conduit en fait à accélérer le processus de dégradation de la pêche traditionnelle, soit en créant des emplois permanents à terre, soit en favorisant la création en un point donné d'une pêche industrielle plus attrayante sur le seul plan de la rentabilité. En ce qui concerne le financement d'opérations de pêche proprement dites, la dispersion des interventions rend très difficile le recouvrement régulier des créances.

Ces obstacles auxquels s'ajoute la nécessite d'unencadrement important pour que les pêcheurs profitent au mieux des nouveaux investissements rendent peu attractives les opérations de pêche pour des investisseurs privés. C'est pourquoi ces types de financement sont entrepris essentiellement dans le cadre d'interventions d'assistance technique bilatérale ou multilatérale, par des agences nationales de développement, avec les risques d'une bureaucratie lourde et d'une technocratie souvent en porte à faux avec les contraintes du milieu naturel local.

### *Amélioration de l'embarcation*

Elle est conditionnée par la libre disposition de troncs d'arbre convenables et de ce fait les possibilités sont de plus en plus limitées. La substitution d'une embarcation à structure longitudinale par une embarcation réalisée à partir d'une structure transversale ('métamarisée'), avec des matériaux naturels ou synthétiques semble la seule solution à long terme.

Elle est cependant freinée par le coût de cette nouvelle unité qui doit être le plus proche possible de l'ancienne et par les performances qui doivent être comparables en particulier pour l'échouage (poids, resistance, etc) ou pour le franchissement de la barre. La nouvelle unité devra vaincre pratiquement les mêmes contraintes que celles de la pirogues même si leurs limites sont plus étendues en ce qui concerne la durée de la sortie en mer, la productivité, les moyens de conservation des captures à bord.

*Avantages de la motorisation:* Ils n'apparaissent que dans des conditions bien précises, lorsqu'il existe le long des côtes concernées, des zones de captures, situées à une distance telle des points de débarquement qu'elles ne peuvent être fréquentées par une embarcation mue à la voile lors d'une sortie d'une journée mais par une pirogue pourvue d'un moteur à régime rapide ayant quelques heures d'autonomie.

La motorisation ne présente que peu d'intérêt dans les zones à vents de mousson ou alizés forts et réguliers. Par contre, elle peut libérer le pêcheur de la sujétion des vents locaux à période journalière. L'utilisation de moteurs hors bord ou de moteurs fixes à arbre à transmission par cardan évite la réalisation d'infrastructures de débarquement onéreuses. Enfin la diminution du temps de mer après la pêche peut, dans une certaine limite, apporter une amélioration non négligeable de la qualité des captures au débarquement.

*Problèmes liés à la motorisation:* La motorisation implique: la formation professionnelle préalable des utilisateurs; la mise en place d'un encadrement technique important pour l'approvisonnement, l'entretien et la réparation des moteurs; et la mise en place d'une organisation administrative cohérente que ne doit pas aliéner la propriété individuelle comme le font malheureusement les structures jusqu'à ce jour proposées, qu'elles soient collectivistes ou coopératives.

Quelque soit le degré de dépendance de l'individu par rapport à la collectivité dans la société d'un pays en voie de développement, il apparait comme une profonde erreur de méconnaître les potentialités techniques et les capacités de gestion individuelles de chaque pêcheur. C'est au contraire vers une propriété de l'embarcation par le 'patron' à laquelle peut partiellement être associé chaque membre de l'équipage nominativement qu'il faut s'orienter. La notion de responsabilité individuelle est un facteur de progrès capital en vue de l'amélioration du niveau de vie et du niveau social des pêcheurs.

*Aménagements des piroques pour la conservation des captures:* Ces aménagements ne sont de toutes façons destinés qu'à un volume de prises par pêcheur relativement faible (poissons de ligne). Ils ne peuvent être que des solutions très partielles, la forme et les volumes disponibles sur des pirogues rendant impossibles tous aménagements rationnels. Ils supposent en outre l'existence à terre d'un approvisionnement régulier en moyen de réfrigération (glace) rendu généralement difficile, du fait des contraintes d'énergie, des contraintes techniques et du coût.

*Améliorations des engins de pêche*

Depuis la généralisation des matériaux synthétiques, elles sont plus un problème d'assistance technique que d'investissement ou de technologie proprement dit puisque l'embarcation limite obligatoirement le poids, l'encombrement et la mécanisation des engins. Sur le strict plan du coût, des améliorations sensibles peuvent être apportées s'il est possible en un point donné de grouper les achats. Dans ce cas, la création de coopératives d'approvisionnement est un progrès certain, si elles se limitent a ce seul rôle.

*Améliorations par rapport à l'hygiène*

C'est certainement là qu'interviennent les erreurs les plus grossières avec des conséquences considérables sur l'économie de la pêche, alors qu'il est consenti souvent des efforts d'investissement importants en amont.
La mise en oeuvre de pratiques simples, sans dépenses supplémentaires, au point de débarquement réduiraient dans certains cas les pertesien valeur de 70% en supprimant gaspillages et altérations du produit. Ceci sans tenir compte des conséquences fâcheuses non mesurables sur l'équilibre énergétique de la ration et même sur la santé des consommateurs qu'ils soient pêcheurs ou non.

Malheureusement, du fait que ces conséquences ne n'expriment pas immédiatement en termes comptables, elles ne retiennent pas l'attention ou au contraire, elles donnent lieu à des déclarations fracassantes, souvent folkloriques, fondées sur des idées générales le plus souvent erronées de la part des autorités responsables du développement des pêches, même au niveau élevé.

*Observations des règles d'hygiène:* Elles sont élémentaires mais d'autant plus difficiles à faire appliquer qu'elles sont le plus souvent inconnues des pêcheurs et de leurs familles dans la vie courante. Parmi les principales, il faut relever:

1. Hygiène du poisson à bord des pirogues:
    - éviter de blesser le poisson avec une gaffe
    - éviter de l'écrasser avec les pieds au fond de la pirogue
    - ne pas le laisser dans l'eau sale du fond de la pirogue, exposé au soleil
    - l'éviscérer convenablement etc
    - laver les pirogues après chaque marée
2. Hygiène au débarquement:
    - éviter les multiples manipulations
    - éviter l'abandon sur la plage au soleil en attente de sa vente
    - éviter l'éviscération et le lavage dans une seule eau prélevée au milieu des détritus sur la plage et jamais renouvelee, etc
    - éviter l'abandon des viscères et des restes de parage sur la plage.
3. Hygiène du poisson en l'attente de sa commercialisation locale et de son expédition.

    Ceci est certainement le point le plus délicat car il est toujours très difficile d'apprécier la durée exacte de cette attente. Il importe malgré tout que le poisson pendant ce délai soit protégé de toute atteinte mécanique, de toute souillure et surtout de l'action de tout prédateur (insectes, oiseaux, etc). L'éviscération systématique devrait être une règle d'or malheureusement toujours remise en question par des idées traditionnelles ou préconcues.
4. Rôle de l'assistance technique dans le domaine de l'hygiène.

    Il est souvent peu reconnu et quand cette assistance est envisagée, elle porte le plus souvent sur des investissements destinés à réaliser des équipements sans préparation psychologique et technique des pêcheurs, commercants, et consommateurs, auxquels ils sont destinés. Il en résulte soit un accroissement sensible du prix du produit et une diminution de la consommation soit plus souvent l'abandon pur et simple des équipements.

*Conservation des poissons*

La conservation des poissons frais est le problème technique capital dans la mesure où c'est la présentation du poisson en l'état qui prime sur les marchés des produits de la mer et dans mesure où les traitements traditionnels loin de valoriser le produit ne sont entrepris que pour en éviter la perte totale.

La conservation correcte implique le recours au froid mais il est bien évident qu'au niveau du simple point de débarquement cette technique n'est que très rarement justifiée économiquement. Plutôt que de doter les points isolés de débarquement de fabriques de glace et de chambres froides, il est souhaitable:

1. De désenclaver ces points de débarquement pour favoriser l'évacuation rapide dès captures dès leur débarquement vers un centre de regroupement équipé.
2. De réduire la durée du stockage au point de débarquement au strict minimum.
3. De doter ce centre de regroupement de moyens modernes et efficaces de congélation et de stockage des produits congelés et de fabriques de glace pour approvisionner les véhicules faisant la collecte des produits sur les points de débarquement.

4. De prendre des dispositions draconiennes pour éviter que ces équipements, pour des raisons d'économie de fonctionnement, pratiquent la congélation lente et soient utilisés pour la conservation en températures positives.

La non cumulation d'un jour sur l'autre, des sommes consacrées par le consommateur à l'acquisition des aliments périssables ou non, limite les conséquences de rupture de la chaîne de froid entre le grossiste et le détaillant et entre le détaillant et le consommateur.

Le salage-séchage ou le fumage selon les conditions météorologiques ne doivent jamais être considérés en matière de pêche traditionnelle comme des facteurs de valorisation. Ceci en interdit donc toute industrialisation et toute modernisation qui viserait à l'obtention de produits plus sophistiqués mais souvent inadaptés au goût du consommateur. C'est essentiellement dans le domaine de l'hygiène des manutentions, des préparations et du stockage des produits finis que devront être poursuivis les efforts.

*Limites d'utilisation des embarcations traditionnelles*

Ces embarcations contrairement à ce qui est généralement admis, ne sont donc pas un début d'évolution mais un terme. Certes il est possible d'y apporter de nombreuses modifications pour en améliorer la productivité et l'efficacité dans le transport et la conservation des captures, mais toutes ces actions n'auront, nous l'avons vu, qu'un effet limité.

L'exploitation de nouveaux fonds de pêche, de nouvelles concentrations d'espèces marines et la mise en oeuvre de techniques à plus haute productivité, sans un recours à une pêche industrielle modifiant radicalement le mode de vie des populations concernées, ne peut venir que de la mise en oeuvre d'un nouveau type d'embarcation à la mesure des moyens techniques et économiques des pêcheurs. Ce nouveau type peut à son tour, être considéré comme un terme d'évolution et non un élément de transition vers une embarcation appelée à évoluer lentement.

## La peche traditionnelle moderne

Elle est un élément indispensable de l'équilibre économique des pays en voie de développement et seule capable de maintenir (en attendant le développement de l'aquaculture) une activité humaine harmonieuse en zone littorale. Malheureusement, à quelques exceptions près, le niveau des ressources directement exploitables pour l'approvisionnement local, sans bouleverser radicalement les moyens mis en oeuvre pour en tirer parti, ne nous laisse guère espérer qu'un accroissement éventuel modeste du rendement par unité d'effort. Par contre, une meilleure rentabilité des opérations peut être obtenue particulièrement pour le pêcheur, le seul avec le consommateur qui soit en bout de chaîne, si des dispositions adéquates sont prises pour atténuer sensiblement les causes d'altérations et de pertes à chaque étape qui conduit le produit, de sa capture à sa consommation.

*La modernisation : le cordier*

La modernisation de la pêche traditionnelle ne doit donc pas seulement porter sur l'augmentation du taux de capture par unité d'effort mais aussi et surtout sur un accroissement sensible de la qualité des produits. Elle repose donc partout où cela est possible, sur la mise en oeuvre d'une petite embarcation polyvalente, basée en de nombreux points d'implantation disposant d'un minimum d'infrastructures portuaires. Cette unité doit assurer à ses prises la meilleure conservation possible jusqu'au débarquement. A cette embarcation nous donnons le nom de 'cordier' car la ligne à main est la technique principale qu'elle devrait permettre de pratiquer (encore qu'en France une corde est en réalité une palangre fixe, mais le terme de ligneur est aussi équivoque). A partir de cette technique de base, il est toujours possible de procéder à des aménagements complémentaires accentuant le caractère polyvalent de l'embarcation. La décision dépend des conditions rencontrées localement.

*Les avantages du cordier:* Le cordier ne présente pas par rapport à une unité plus forte de restrictions complémentaires en matière de tenue à la mer. Par contre, il représente par rapport aux pirogues ou autres embarcations voisines, les avantages suivants, qui suppriment pratiquement toutes les restrictions imposées à l'exploitation de ces dernières.

1. Sécurité: Le cordier peut réaliser des sorties en mer de plusieurs jours ce qui accroit le rayon d'action et la productivité. Il peut supporter des mers fortes et travailler en zones d'alizés ou de moussons. Il peut mieux se protéger des erreurs de navigation grâce à la disposition d'un sondeur. Il est en liaison permanente avec la terre grâce à son appareillage électronique (radio etc).
2. Habitalité: Le cordier protège l'équipage des intempéries.
3. Surfaces disponibles: Elles permettent d'envisager l'emploi simultané de plusieurs engins (lignes à main, traîne, filets maillants, casiers etc).

   Une certaine mécanisation possible assure un effort de pêche plus grand et permet une exploration des zones de pêche, sous trois dimensions, beaucoup plus étendue (profondeur accrue).
4. Volumes disponibles: Ils garantissent des possibilités satisfaisantes d'aménagements pour un stockage à bord sous froid correct.
5. Infrastructures simples: Bien que par rapport aux pirogues ou embarcations similaires l'exploitation du cordier soit favorisée par des infrastructures portuaires, celles-ci ne sont pas indispensables, ces navires pouvant soit s'échouer, soit être tirés sur une plage par un système de cabestans, palans, rouleaux et glisseurs.

Le cordier est un facteur de progrès technique pour l'équipage. Bien que pouvant être armé par un équipage peu spécialisé (excepté le mécanicien), il permet avec le temps une formation professionnelle sur le tas qui n'existe pas sur une pirogue et donc de meilleures chances d'un progrès social ultérieur.

*Les désavantages possible du cordier: l'investissement et la maintenance.* Dans la mesure où l'investissement s'accompagne d'une meilleure productivité, celle-ci doit avoir pour conséquence une bonne rentabilité financière. Ceci n'est pas évident. Le cordier représente une nouvelle conception 'mécanique' avec pour conséquence des contraintes multiples. Ceci d'autant que l'équipage est moins spécialisé. La principale est la régularité dans les entretiens et les révisions. Ces contraintes ont pour corollaire la nécessité d'un encadrement sérieux, non seulement sur le plan technique mais aussi sur celui de la gestion.

*Le choix des caractéristiques du cordier:* Les caractéristiques sont déterminées par la nature des zones de pêche les plus fréquentées et de leur localisation, des espèces les plus recherchées, et de l'organisation de la sortie en mer et de sa durée.

Ainsi une unité de 12 m dont l'autonomie demandée est de 48 heures, qui emportera 1 t de carburant, 150 kg de glace et rapportera 150 kg de poissons, aura approximativement 3 m 60 de large, 1 m 60 de creux et un moteur de 150 CV. Au contraire, une unité de même longueur dont l'autonomie souhaitée est de 6 jours, conçue pour capturer en priorité les espèces pélagiques et qui emportera 4 t de carburant, 3 ou 5 t de glace et rapportera 2 ou 3 t de poissons aura approximativement 4 m 30 à 4 m 50 de large, 2 m de creux et un moteur de 100 CV. La jauge brute sera le double.

Dans la mesure où la rentabilité aura été soigneusement étudiée, il ne serait pas souhaitable de rechercher un coût d'investissement minimum pour réduire la différence par rapport à l'investissement d'une pirogue. Le recours à un échantillonnage 'économique', à un équipement moteur, hydraulique, électrique très simplifié serait une erreur pouvant provoquer des réductions importantes de temps de pêche et des augmentations de coûts de maintenance.

Le choix des techniques de pêche à mettre en oeuvre est évidemment fonction des zones de travail et de la production saisonnière des diverses espèces marines recherchées. Il sera dicté par la nécessité de maintenir une haute productivité tout au long de l'année donc par la nécessité d'une grande adaptabilité et par le choix des espèces à haute valeur marchande.

### *L'effort sur l'équipement de stockage*

Dans la mesure où la recherche de la qualité est capitale, un soin particulier sera apporté aux conditions de conservation sous froid à bord. En effet l'orientation de l'exploitation de ces unités est essentiellement la recherche d'espèces nobles vivant sur fonds accidentés, les moins accessibles aux autres embarcations traditionnelles ou industrielles. Ce sont ces espèces qui font les meilleurs prix sur le marché local et désormais le plus souvent à l'exportation, destinés qu'ils sont à une clientele aisée des pays industrialisés.

Parallèlement à cet effort consenti dans l'équipement (cales isothermes, plastifiées, facilement lavables etc), un effort identique devra être engagé pour la formation technologique des équipages, jamais conscients des conséquences de leur négligeance dans les diverses manipulations qu'ils font subir aux poissons capturés (coups, blessures par gaffe, exposition au soleil sur le pont, éviscération imparfaite, glaçage avec une glace mal concassée, souvent sale ayant déjà servie, tassement des poissons en cale etc). Il est certainement très difficile d'exiger de ces équipages des précautions qu'ils négligent régulièrement dans leur vie courante et dont souvent ils ne voient que le caractrès discriminatoire à leur égard. C'est pourtant là une des clés d'une meilleure rentabilisation de leur travail, car des précautions prises en amont de la chaîne de commercialisation dépendent les niveaux de qualité successifs à chaque étape ultérieure de la distribution. Il est impossible de corriger par la suite les erreurs faites sur les manipulations et traitements lors d'une étape antérieure.

### *Aménagements terrestres lors de la mise en exploitation des cordiers*

Dans la mesure où la mise en exploitation des cordiers doit s'accompagnier d'une rationalisation des conditions de manipulation, traitement et commercialisation des captures, un certain nombre de contraintes terrestres apparaissent: désenclavement du point de débarquement (il faut que le produit puisse atteindre rapidement soit son centre de commercialisation définitif, soit un centre d'éclatement); libre disposition d'eau potable pour toutes les opérations de lavage; et structures de production de froid.

Si le point de débarquement est un centre important de commercialisation, elles consisteront essentiellement en:

1. Une fabrique de glace d'une capacité de production équivalente aux besoins journaliers augmentés de 30% et d'une capacité de stockage égale à deux fois la consommation journalière. La consommation journalière doit être calculée sur la base de 3 kg de glace pour 1 kg de capture.
2. Des chambres de stockage en températures positives (0–2°C) d'une capacité équivalente à 3 jours d'apport de pointe.

Si le point de débarquement n'est pas un centre important de commercialisation, les installations de froid devront comporter:

1. Une fabrique de glace de capacité identique a la précédente mais calculée sur la base de 2 kg de glace pour 1 kg débarqué par jour.
2. Un moyen de congélation (air pulsé ou plaque selon la nature et l'importance des divers types de produits) d'une capacité correspondant à 50% des apports maximum journaliers.
3. Des chambres de stockage en températures négatives (−18°C) d'une capacité équivalente à 4 jours d'apports maximum.

Une infrastructure de réception et de conditionnement des captures ne sera en aucun cas une criée qui ne joue, dans les pays en voie de développement, pratiquement son rôle qu'au détriment du producteur, mais une aire couverte sous laquelle seront effectuées obligatoirement toutes les opérations: de glaçage, de triage, d'éviscération éventuelle, de reglaçage, de conditionnements divees, de stockage des coffres, de nettoyage, des coffres, de préparation éventuelle à la congélation etc. Elle devra permettre dans toute la mesure du possible, une simplification de toutes les manipulations qui devront être mécanisées au maximum pour des raisons évidentes de salubrité.

Les structures de transformation ne seront envosagées que dans le cas où la capture des espèces pélagiques côtierès représente au moins 75% des apports et sur un rythme journalier moyen de 20 t (pour 250 jours par an). Dans les points de débarquement, non désenclavés, sans marché local important, mais disposant d'une source d'énergie approvisionnée aisément en carburant et dans lesquels le volume des apports en poissons quelq'ils soient, dépasse 10t par jour une installation de production de farine de poisson pourra être recommandée. Il est bien évident que ces seuls équipements ne feront pas disparaître les pratiques qui actuellement provoquent un gaspillage considérable de protéines animales. Ce progrès ne pourra venir que d'une action à long terme, conduite avec persévérance et ténacité, sur les divers agents qui interviennent à tous les stades dans les circuits de distribution.

Nous l'avons dit, pour pallier les gaspillages, il n'est souvent pas suffisant de disposer d'investissements importants, implantés tout au long des côtes sans étude préalable, sans souci d'économie dans une optique souvent politique même démagogique ou les deux à la fois, puisque la pluplart du temps aucun personnel qualifié n'existe pour leur entretien et leur exploitation et aucune action d'information n'a été entreprise auprès des utilisateurs éventuels pour lesquels ils ont été réalisés. Les actions de formation et d'information ne pouvant venir que de la puissance publique coûtent cher et demandent beaucoup de continuité pour être efficaces. De plus et surtout elles doivent se traduire, pour les agents qui les acceptent et ultérieurement font l'effort nécessaire pour les mettre en pratique, par une amélioration sensible de leur situation que ce soit au niveau de la rémunération pour les agents responsables des équipements ou du contrôle des produits ou que ce soit au niveau de la revalorisation du produit pour le producteur ou le commerçant.

### *Rôle de la puissance publique dans la mise en exploitation des cordiers*

Le passage de la pirogue traditionnelle au cordier implique de tels changements et la mobilisation de telles ressources qu'il est impensable qu'une telle opération soit conduite sans l'assistance de la puissance publique dans un pays en voie de développement. Cette assistance devrait se manifester aux niveaux suivants:

1. Aide financière sous forme de subventions et de prêts à taux d'intérêt bonifiés pour 60 à 80% du montant des investissements.
2. Aide technologique au niveau de la formation non seulement des jeunes mais des adultes. Attribution de facilités financières à ceux qui ont obtenu les meilleurs résultats. Formation non seulement orientée sur la navigation, la mécanique mais aussi la gestion et surtout l'hygiène des produits à tous les stades de la commercialisation.
3. Encadrement technique; le démarrage de l'exploitation rationnelle d'une flottille de cordiers suppose un encadrement technique et un contrôle de gestion par des spécialistes, le plus souvent recrutés parmi une main d'oeuvre spécialisée expatriée, fournie dans le cadre d'une assistance technique bilatérale ou multilatérale.
4. Mise en place d'un atelier d'entretien et d'un magasin coopératif d'avitaillement pour l'approvisionnement en pièces détachées et en matériel de pêche de la flottille.

### Conclusion

Ainsi le cordier apparait comme le premier maillon d'une modernisation de la pêche traditionnelle sans en changer sa structure. Très adaptable à des bases d'armement les plus variées, il peut se contenter d'un sommaire point de débarquement ou se trouver facilement exploitable à partir d'un port parfaitement équipé. Conçu principalement pour l'exploitation des espèces démersales à la ligne à máin, il peut grâce à un minimum d'équipement devenir aisément polyvalent.

Mais c'est sur le plan des conditions de conservation des captures à bord qu'il est vraiement une étape nouvelle. A partir de ce progrès considérable peut être envisagé une nouvelle conception de la commercialisation des produits de la pêche, de l'approvisionnement du marché local et des possibilités d'exportation. Désormais les gaspillages dus aux pertes importantes dès le débarquement peuvent être réduits au strict minimum, assurant ainsi à la pêche traditionnelle une compétitivité par rapport à la pêche industrielle garante de l'avenir de toute une population littorale pour laquelle la merest non seulement une source de revenus mais surtout un mode de vie auquel elle est fortement attachée.

# Fisheries development in Malawi: commercial trawling

**A. J. Mathotho**
Ministry of Agriculture and Natural Resources, Malawi
and
**J. F. Rogers***
FAO/UNDP Fisheries Project, Malawi

## Summary

The need and opportunity for a fish landing centre and wholesale market, showing the shared effort in its establishment, is described. The work of the landing, fish processing experiments and fish trading and transport are reviewed after two years' operation, and a discussion on the problems and achievements so far and their probable value now and for the future is included. The benefits of co-ordination between different organizations are seen to be maximized by co-operative flexibility at an operational level.

## Résumé

La nécessité et l'occasion de construire un point de débarquement et d'un marché en gros est indiqué dans cet article ainsi que les efforts que demande sa réalisation. Après deux ans d'activité, le débarquement, les méthodes de préparation du poisson, sa commercialisation et son transport sont passés en revue et il est fait état des problèmes et des réalisations ainsi que de leur importance actuelle et pour l'avenir. Il apparait que les avantages d'une coordination entre les différentes organisations sont amplifiés par une souplesse de coopération au niveau opérationnel.

## Resumen

Se describe la necesidad y oportunidad de un centro de descarga de pescado y un mercado al por mayor, mostrando los esfuerzos compartidos para su establecimiento. Después de dos años de funcionamiento, se revisan los trabajos de descarga, las experiencias de elaboración de pescado, y la comercialización y transporte del pescado, discutiéndose los problemas y logros conseguidos, así como su posible valor actual y futuro. Los beneficios de la coordinación entre diferentes organizaciones se han elevado al máximo mediante una flexibilidad cooperativa a nivel operacional.

## Introduction

With the development of a new, bottom trawling industry to exploit previously untapped resources in Lake Malawi, the establishment of centralized landing facilities, for handling and distributing the greater quantities of fish and for providing the necessary facilities and services for the trawlers, became essential. The first landing was sited at Namiasi on the western shore of the south east arm of Lake Malawi, a position fairly central to the first area trawled and with good communications and mains electricity. It was intended that the landing should serve as a pilot model to determine suitable handling, processing and marketing techniques which could be implemented at further new landings, as trawlers are introduced to other parts of the lake.

The Fisheries Department of the Malawi Government, the Food and Agriculture Organization (FAO) of the United Nations and the Tropical Products Institute (TPI) of the British Ministry of Overseas Development (ODM) co-operated in the establishment and operation of the Namiasi Landing. Other departments of the Malawi Government and various national and international agencies also assisted in certain aspects of the work.

The contributions of these bodies were as follows:

Malawi Government –
- Counterpart staff and general labour
- Staff accommodation
- Landing, market buildings, laboratory and

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*Present address: Tropical Products Institute, UK.

laboratory furnishings
Improved access road
Jetty
Fish drying racks
Recurrent maintenance expenditure: electricity, water and telephone

FAO –

Fish processing technologists
Fish marketing officer
Ice plant and ice store
Chill store
Mechanical drier
Torry kiln (mechanical smoker)
Water pump, filtration and chlorination equipment
Vehicles and insulated fish containers

TPI –

Fish processing technologists
Laboratory equipment
Technical library
Analytical services
Food chemist

Two fish processing technologists were seconded (at different times) by TPI to FAO for the execution of the fish handling and processing section of the project.

The co-operation between the Malawi Government and FAO is the result of a joint project: The Promotion of Integrated Fishery Development. The project covers all aspects of the development of the bottom trawl fishery which was discovered and introduced in 1968. Also TPI has a joint project with the Malawi Government, under the terms of an ODM Research Programme, to investigate aspects of fish handling, processing, marketing and quality control. An officer under UK technical co-operation is currently based at Namiasi to continue the work for the next two years. It is hoped that the work will lead to the introduction of codes of practice for the fishing industry as a whole.

## The fish market

The landing has been operational since July 1973. Initially, only one pair trawling unit was using the landing but the number has steadily increased as new units were constructed. Resource studies have indicated a maximum of five fishing units for the area and the full quota has been in operation since August 1975.

Charges are levied for the use of the facilities and service provided to put the landing on a commercial footing. A 'pool' of wooden fish boxes is provided and the fishermen and traders are charged a nominal daily rent of 1 tambala* per box. Lubricants and fuel oil are available on the site; servicing and minor repairs are also carried out by departmental staff. A jetty, 3m wide and 66m long, was constructed, allowing the trawlers to come alongside regardless of lake level and under most weather conditions. Trolleys are provided to move boxes of fish from the boats to the market floor where they are check weighed. A supply of portable piped water is available at several points on the market floor and most traders wash their fish before transporting; removal of surplus slime, dirt and gut contents improves the appearance and subsequent drying rate.

In the first few months of operation, a number of changes in handling practice were made until a satisfactory system was established. Currently, boxes of fish are unloaded directly onto the trolleys and the boxes are then check weighed, to contain 60lb (27 kg) of fish, before stacking onto the market floor by type, eg chisawasawa and utaka, for each fishing unit. The boxes are sold at a fixed price of K1.50 for chisawasawa (mainly *Lethrinops* spp.) and K2.00 for utaka (*Haplochromis* spp.).

Each unit's catch is counted after check weighing and the total amount landed is agreed between the market staff and the boat owner. As soon as the quantity landed is known, the fish are divided amongst the traders registered for that day. For most of the year, demand exceeds supply and a register of traders is maintained to ensure equitable distribution. A certain degree of preference is shown to established traders who continue to purchase throughout the wet season thereby allowing the boats to continue fishing; many of the smaller traders disappear during the wet season.

Box losses increased considerably when non-departmental transport was used to carry fish and a deposit of K2.00 per box, taken from the market, was introduced in an attempt to reduce losses. The number of boxes issued to fishermen is checked and any losses charged.

Fish are sold on a 'cash only' basis except for purchases by Government institutions. All revenue is paid into a Treasury deposit account. At the end of each month, the books are closed and a financial statement is prepared. Payment vouchers are prepared for fishermen after deduction of market charges, fuel and servicing costs, loan fund repayments and any other incidental charges (eg insurance of fishing gear). Since the fishermen are provided with the boats and fishing gear on a loan scheme, strict control of their earnings is necessary to ensure loan and other repayments. The landing has to operate within the Government's financial regulations and cash payments to the fishermen on a daily basis would be impossible. The income of the market from various fees, rental charges and ice sales is transferred at the end of each month to an 'appropriation-in-aid' vote of Fisheries Department Headquarters. Monthly financial statements must balance exactly before any payment vouchers are prepared; this ensures accuracy in handling the fishermen's money and reduces opportunities for misappropriation. It is hoped that eventually the market will be operated on a fully commercial basis and all expenses will be covered by earnings. At the moment, revenue earned is not directly available to the market.

A number of lock-up stores are rented to traders so that they can stockpile dried fish until transport to the market is arranged. To facilitate the transport of dried fish to the market, Malawi licenses a number of public service vehicles (fish); these are partly enclosed lorries that are licensed to carry passengers (ie the traders) as well as fish. A regular service is run along the southern lake shore to the major population centres in the Southern Region.

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*1 Malawi Kwacha (K) = 100 tambala = US $ 1.20

## Fresh fish

The proportion of the catch marketed fresh in the main population centres, which are only about four hours away by road from the market, is increasing. A number of traders, using one ton pick-ups, take fresh fish in ice to the main urban markets. No insulation and very little ice is used but the fish find a ready sale. An insulated box has been constructed that fits into one of the pick-ups and will carry the maximum load of the vehicle. Trials are underway to test the efficiency and robustness of the construction.

FAO have provided a seven ton lorry and two insulated containers for the distribution of iced fish. Trials have established that a ratio of two parts of fish to one of ice is adequate for chilling and for up to 48 hours storage in the container. Problems with the ice plant and marketing have prevented extensive trials. Small traders not using ice or insulation can easily undercut the price at which fish could be sold on the urban markets. Until consumers are prepared to pay slightly extra for improved quality, the marketing of iced fish will be difficult.

## Fish processing

Traditionally, small species of fish (the bulk of the trawlers' catch) are sun dried before marketing. For nine months of the year, weather conditions are favourable and few problems occur; the fish dry to one third of their wet weight in about three days. During the wet season, however, sun drying is more difficult and quality decreases markedly due to insect infestation. The damage caused by blowfly larvae can be severe; often only skin and bones are left after all the flesh has been eaten by the larvae. Occasionally, fish may be lost completely if rain persists for several days. Chisawasawa, which form 80% of the catch, are one of the least preferred fish and provide a source of protein for the section of the population with low purchasing power. Any processing must, therefore, add very little to the cost if the fish are to remain within the reach of the low-income groups, who cannot afford to be discerning over the quality of the fish they purchase. A number of improved methods have been investigated.

### *Mechanical drying*

An oil fired mechanical drier was used experimentally to dry fish during the wet season. Although the final product was of good quality and fully comparable with the best sun dried fish, the additional handling and cost of fuel and electricity made it economically unattractive. Changes in market preferences and fish prices may, however, make mechanical drying economically feasible in the future.

### *Drying: pyrethrum washing or dipping*

The application of pyrethrum, to control blowfly larvae on the drying fish, was investigated. The indiscriminate use of insecticides is not allowed in Malawi and it is intended to develop a method that will be effective, as well as acceptable, to the Public Health Authorities. Spraying equipment is relatively expensive and must be kept in good condition to operate efficiently; this may be beyond the financial ability of many small traders. Also, control of the insecticide used and the rate of application may well become impossible if traders are allowed to have their own equipment.

Pyrethrums denature rapidly in sunlight and surface applications by sprayers may be ineffectual. A brief but liberal washing technique at the landing, without removing the fish from the boxes, appears the most practical method of application. Analysis of residual pyrethrum levels shows an increase in concentration over the drying period following a washing or dipping technique; presumably, the pyrethrums penetrate into the gill chamber and body cavity and are then protected from sunlight during the drying period. In contrast, residual levels in spray-treated fish fall rapidly over the drying period. If residual levels can be kept within the Codex Alimentarius recommended limits (three parts per million for pyrethrums and twenty parts per million for piperonyl butoxide) and yet remain effective throughout the drying period, it may be possible to use a very low initial dosing rate. It is estimated that fish could be treated for traders at five tambala per box, which would cover insecticides, equipment and labour.

### *Salting and drying*

Heavily salted fish are not traditionally eaten in Malawi and, although salting before drying would reduce insect infestation, consumer acceptance problems must be overcome. A brining, sun drying technique for chisawasawa, which improved appearance and greatly reduced insect infestation during drying and over several months dry storage, was developed. Unfortunately, a commercial pilot-scale experiment to sell brined fish was handled badly. The fish were sold bagged by weight and, when the traders discovered that each bag contained fewer fish than with unsalted dried fish, they were openly hostile and further trials were not possible. Salted sun dried and wet salted fish are, however, prepared in limited quantities for export. This method should be tried again in the future.

### *Smoked catfish fillets*

For the higher-income consumer, a brined and smoked fillet has been developed using catfish (*Bagrus* sp.). The final product is somewhat similar to smoked haddock or hake and finds a ready sale amongst the local higher-income group and the hotel trade. An agreement was made between Maldeco, a large commercial fishing company, and the Fisheries Department to produce the fillets on a commercial basis. Maldeco were to supply the raw material and to pack, freeze and market the fillets after processing at Namiasi. Unfortunately, catfish have declined in the trawl catch recently.

### *Fish drying racks*

A number of chicken wire covered racks were constructed and rented to traders. For the first year polythene sheeting was supplied for the wet season. The racks were intended as a demonstration and traders are now building their own racks and buying polythene sheeting. Traditionally, racks covered with split bamboo are constructed. These are less efficient and are inconvenient to use since fish tend to drop through the spaces between the bamboos. Traders are allowed to use market trolleys to carry the fish from the market floor to the drying racks. Several pick-up owners transport the traders and their fish to racks some distance from the market.

### Other resources

Quantities of molluscs, mainly gastropods, are sometimes caught by the trawlers. Certain grounds are avoided because they are liable to yield large catches of molluscs, which are heavy and difficult to haul and tend to damage the gear. The molluscs are not eaten in Malawi and are unsaleable. Investigations have been conducted to establish whether the molluscs could be used for inclusion in animal feeds. Malawi imports fish meal to formulate animal feeds and it was hoped that the dried meat would provide a suitable alternative. Unfortunately, analytical results were not encouraging; the dried meat contained too high an ash level and a relatively low protein level. It may, however, be possible to use the ground shells as a source of calcium and grit for inclusion in poultry feeds.

### Discussion

The establishment of the landing and the market at Namiasi is part of a much wider development scheme involving a number of organizations (see Appendix 1). A major part of the 'Promotion of Integrated Fisheries Development' project has been the introduction of a highly successful bottom trawl industry. The project, in association with Danish aid and the Malawi Government, has established a boatyard, trained boat builders and constructed 25 ft trawlers. In association with British aid, they made the gear and trained the owners and crew to operate it. Studies have been undertaken to establish the size and distribution of fish stocks and the effects of fishing pressure have been monitored since regular commercial trawling began. A loan scheme, with compulsory training and directed landing of fish to the market(s), was also administered by the project and financed by the Christian Services Committee. Namiasi Landing has been responsible for handling the catch of the newly established trawl industry and developing handling techniques suitable for relatively large quantities of fish, when compared with the traditional canoe fishery. A measure of the success of the project to date is that all the units financed by the loan scheme are well ahead of their repayment schedules: the best repaid a five year loan in one year, solely from the minimal repayment percentage charged in the market. Since commercial pair trawling began, 5338 tons of fish have been landed; the average catch per unit per day at Namiasi is 2.03 tons.

Co-operation between the Malawi Government and the multi-lateral and bi-lateral aid agencies has increased the overall efficiency of fisheries development in Malawi. The TPI/ODM laboratory at Namiasi was fitted out as part of the work of the FAO fish processing technologist. Laboratory equipment provided by TPI is used for FAO project work at Namiasi and elsewhere on the Lake, for example: the limnologist, based at Chintheche in the Northern Region, would have had to wait several months for equipment delivery but for a loan from the Namiasi laboratory. Specialist analytical services have been provided by TPI in London for the investigation into the application of pyrethrums to control blowfly infestations on drying fish. Samples for the normal TPI work programme, not exclusively relevant to the FAO project or Malawi's immediate needs, have been collected, packed and freighted to London. TPI staff, not necessarily working in fisheries, have paid short visits to Malawi. Without the assistance of Government and FAO staff, they could not have completed their work programmes. Fisheries Department staff, on FAO overseas training fellowships, have received part of their instruction at TPI in London. All FAO and TPI experts working on this project are expected to train their Malawian counterparts to ensure continuity of the work when the project is phased out.

The partners in the development of Malawi's fisheries have maintained a very flexible attitude, often extending a strict interpretation of their terms of reference for the benefits of greater efficiency, quicker operation and financial savings. The successful execution of the fisheries development programme outlined in this paper provides an example of co-operation between the number of organizations involved which could well be of value in similar situations in many developing countries.

## APPENDIX I

## Bodies associated with the development work

| *Name of organization* | *Work connection* |
|---|---|
| Malawi Government: | |
| Ministry of Agriculture, Fisheries Department | Administrative and financial control all aspects of the work |
| Agricultural Department<br>Crop Storage Officer | Insecticide experiment |
| Agricultural Department<br>Department of Extension Aids | Publicity photographs |
| Ministry of Works | Advice and assistance construction |
| Ministry of Finance | Financial supervision |
| Department of Forestry | Timber selection and supply |
| Government Corporations: | |
| Malawi Development Corporation | Business experience, technical investigation, ice supply, smoked kampango production |
| Malawi Broadcasting Corporation | Publicity |
| ESCOM | Electrical installations |
| FAO/UNDP Promotion of Integrated Fishery Development Project | All aspects of the work |
| BHC/ODM/SADD | Training, other support to Malawi Government |
| Tropical Products Institute | Secondment officers, specialist analytical facilities, training |
| British Council | UNV/stock assessment biology |
| Nederlandsverein/UNV | UNV engineering construction |
| Deutsches Entwicklungsdienst | UNV/boatbuilding |
| USAID | FAO/economic appraisal |
| PCV/MG | Administration and liaison |
| Christian Services Committee | Loan fund capital |
| DANIDA | Boatyard, boatbuilding |
| SVADP | Fish farming |
| NORAD | Training |

Various commercial concerns have been extremely helpful with specialized advice and assistance, often beyond normal commercial service.

# The role of the fisheries extension service in rural development

**R. C. Cole**
Tropical Products Institute, UK

## Summary

The ways in which a fisheries extension service, designed particularly to serve the artisanal or small-scale fisheries sector, should be formed, trained and administered are discussed. The duties common to most extension services are reviewed and possible links with other services, such as rural development and co-operative society advisory services, are discussed.

The point is made that an extension service can play a full role in the development of the community it is planned to serve, only if its activities are accepted as being an essential part of the community's existence.

## Résumé

Dans cet article sont discutés les moyens par lesquels un service d'extension de la pêche, conçu tout particulièrement pour être au service du secteur artisanal ou de petite dimension de la pêche, devrait être créé, formé et administré. Les obligations communes à la plupart des services d'extension sont passées en revue, ainsi que la possibilité de relations avec d'autres services tels que le développement rural et les services consultatifs des sociétés coopératives.

L'attention est attirée sur le fait qu'un service d'extension peut jouer un rôle important dans le développement social, seulement si le groupe social accepte ses activités comme essentielle à la vie de ce groupe.

## Resumen

Se discuten las distintas formas de organización, adiestramiento de personal y administración de un servicio de extensión pesquera diseñado particularmente para asesorar al sector de las pesquerías artesanas o a pequeña escala. Se revisan las actividades comunes a la mayoría de los servicios de extensión y se discuten las posibles conexiones con otros servicios, tales como los servicios de extensión de desarrollo rural y de asesoramiento a las cooperativas.

Se pone de relieve que un servicio de extensión solamente puede desempeñar plenamente su papel en el desarrollo de la comunidad para la que esta planeada si dicha comunidad acepta sus actividades como parte esencial de su existencia.

## Introduction

At the lowest levels of rural existence, there is no room for failure because there are no reserves. The failure of migratory fish to appear in their appointed season, the loss of a catch through gear failure, loss of gear through stress of weather or the loss of a batch of processed fish through spoilage are major disasters. In extreme cases, such disasters lead to starvation and death. No one should be surprised, therefore, if peasant fishermen are reluctant to give up established and thoroughly tested practices in favour of untried innovations. This is especially so when the new practices are presented by people who would probably starve on the beach if they tried to make a living from fishing, fish handling or fish marketing.

Arguments against new practices range from 'that is not our way' through 'maybe that does work elsewhere but it won't work here' to 'the spirits would not approve of that'. At the root of the speaker's objections lies the knowledge that his own operations are on such a tiny scale and offer such low margins of profit that he cannot afford to experiment. He dare not take any unnecessary chances with his all too fragile means of livelihood.

So changes come slowly and, at each stage, the profitability must be adequately proved and demonstrated before a new practice can become acceptable. There is seldom any problem in introducing changes which can be shown to be profitable or to make life easier.

The introduction of synthetic materials for net and line manufacture and of internal combustion engines to drive fishing craft are obvious examples. So is the use of ice to preserve the catch although it is often much more difficult to effect improvements in product quality. Such improvements almost invariably raise the price of the product as, of course, does icing and most consumers in developing countries are unable to pay a premium price for better quality, much as they may prefer a better product.

### Problems of relocation

If we define rural development as the improvement of the living standards of the people in rural areas, we need to look far beyond the concepts of fisheries development which are usually uppermost in the minds of fisheries department administrators. Typically the eight or nine million artisanal fishermen of the tropics live in small groups in ramshackle housing, totally lacking the amenities of modern life such as piped water, electricity, effective sanitation, education, and perinatal, medical and dental care. Often, villages are isolated by poor roads; some can be reached from outside only by water, some are seasonally inaccessible. Development requires attention to all these factors as much as to the improvements of fishing boats, fishing gear, berthing or beaching facilities and handling, processing, preservation and marketing methods.

One simple way to overcome many of the difficulties would seem, at first sight, to uproot entire villages and move them to new locations, where the facilities, previously lacking, either exist or can be readily provided. This is seldom an acceptable solution. Many of the people involved are fishermen/farmers who own housing and land (Lawson, 1972). The land which provides much of the villages' subsistence could not easily be provided elsewhere. There are also religious objections based on factors such as the desire to be near ancestral graves; these and similar factors render the people immobile. Most governments are already battling against the ill-effects of the cityward drift of the peasantry and would wish to do nothing which might increase or accelerate this.

However, the main reason for deciding against relocation of whole villages lies in the factors which are responsible for their development on the existing sites. The most obvious of these is proximity to the fishing grounds which include estuaries, mud-flats, shallow banks, lagoons, mangrove swamps and coral reefs. These grounds can be fished most profitably from small vessels of shallow draught and, in producing fish from such areas, the artisanal fisheries can make useful contributions to the economy (Cole, 1973). Long runs to and from the grounds reduce fishing time, and thus profitability, and, of course, increase the time the fishermen are at risk in times of bad weather.

### Research and development

The fish landed in these villages often includes both low bulk, high value items (such as prawns and crawfish), on which export industries may be based, and bulky low value items (such as mussels, cockles and clams), which provide cheap food of high quality. These artisanal fisheries also provide considerable employment using low capital inputs; such important national assets should be developed so that the fisheries continue to be productive while the people involved enjoy at least some of the amenities of life which many take for granted. This usually requires that improvements are made in both the working and living conditions. While some of the improvement may be paid for by the injection of capital from outside, in the long run, the improvements (or at least the maintenance of these) must be paid for by increasing the profitability of the fishing and fish marketing operations: thus, the real income of those engaged in the fisheries is increased. James (1977) elaborates these points.

The development of the industrial elements of an artisanal fishery (as any other fishery) requires that all sectors of the industrial operations should be considered for improvement. Thus, a proposal to fish further to seaward or to use bigger nets may generate a need for bigger boats of deeper draught, which in turn need deeper water and mooring, more fuel and ice, and which demand a higher degree of skill in the crew. The heavier catches expected will require more, or possibly different, processing facilities, bigger or more markets, more transport, better roads and, possibly, the development of an export market with the attendant necessity to meet foreign standards of hygiene, packaging and product quality. Thus, expertise in a number of very different specializations might be needed and there will be a need for research and development (R and D) in many of these.

R and D is, of course, totally wasted unless the results are applied and, in the case of the artisanal fisheries, the results must be applied by people who suspect that all change is not necessarily for the better. Like any other people, they are likely to accept advice most readily from someone they trust as having their best interests at heart. R and D must therefore logically be followed by extension work (E) and, particularly in the artisanal fisheries context, it makes better sense to talk of R, D and E rather than R and D alone. It should certainly not be assumed that extension can stand alone either for there are few cases where unmodified technology transplants successfully from temperate to tropical conditions.

The development of an artisanal fishery in most circumstances requires a modest amount of applied research and a great deal of hard work at the basic village level by officials (or unofficials) who have received adequate technical training, who understand the intricacies of the technical and socio-economic aspects of the industry and are trusted and respected by the people who run the industry. This should be an extension service. In visiting eighteen developing countries in 1974/75 (in SE Asia, Southern America and Africa), I found no single fisheries extension service which I thought to be even reasonably effective.
So perhaps it may be worthwhile to examine the concept of a fisheries extension service in somewhat greater detail.

## Organization and administration of extension services

Wherever possible, the extension service should be organized at the national or federal level rather than at the state or other subsidiary level. Of course, much good extension work is carried out by universities, regional laboratories and similar organizations. This is particularly so in the developed countries where the fishing industry is at an advanced level and where high level expertise is needed. In these situations, the industry solves the simpler problems for itself. Those working in the industry are educated to secondary school or higher levels and if they cannot resolve a problem themselves they can contact a laboratory or other organization and explain their needs. The illiterate or semi-literate peasant fisherman cannot do this and needs a very different kind of service. He needs someone close at hand who can satisfy his simpler needs and can translate the more complex needs into terms easily understood by the more expert. Simple problems can often exist undetected for years simply because there is inadequate contact between the fishermen and those paid to serve them. Sometimes there appears to be no contact at all between government and the fishermen, other than the minimum required for the collection of taxes and statistics.

This essential contact between government and industry requires the employment of rather large numbers of people at the village level and the basic principle of the fisheries extension service is the employment of workers who live among the fishermen. These people must inevitably be trained as generalists rather than as specialists; this means that their skill and knowledge in any particular subject will be limited and, indeed, will often be rather basic. They should be so trained that they can identify the needs for a particular kind of expert assistance and know where this can be found. Thus, the service as a whole should be able to draw on the expertise and experience of various branches of the fisheries department, other government departments, the research and experimental stations, universities, and the fisheries training institutes and schools. Co-operation from these organizations would best be assured by central controls.

### *Control structures*

Where the fisheries department is responsible for fisheries development, it follows that the fisheries extension service should be a branch of the fisheries department. Other arrangements are possible but this is the one that usually seems to work best. Among other things, it permits financing of the service from the national treasury. It also provides for one of the essential requirements of the extension service, ie that those employed should work on a full-time basis. It also helps to provide a career structure offering the possibility of promotion within the extension service or into other branches of fisheries work. If the service is organized on a very small scale, it can provide few posts above the basic level and a further problem is that it cannot provide adequately for specialist posts for technologists above this level. The very smallest countries, of course, can afford to employ only one man as a fisheries extension worker and must seek expertise which he is unable to provide from outside.

A further reason for suggesting that the extension service, which can be provided by universities and similar bodies in the developed countries, would prove unsatisfactory in the developing world is the need for assistance with the socio-economic factors which control living rather than working conditions in the artisanal fisheries of the developing country.

A senior member of the fisheries department should be in charge of the extension service and it is preferable that he should have no other duties. In addition to employing approximately one worker for every 500 fishing families, the service should employ people in a supervisory grade at a ratio of about one to every five field workers; in very large countries, it may be necessary to employ people who control the supervisors in an approximately similar ratio. Whether it will be necessary for the service itself to employ specialists or not depends largely on the size of the country and the way in which the fisheries department is organized. Where the extension service is large, it is obviously best to employ specialists who are trained in their own technology but have also been taught how to operate as extension workers. Where the service is smaller, it is certainly not essential that specialists should be employed; staff in other branches of the fisheries department can be trained for extension work and be required to perform extension duties as part of their normal functions.

### *Terms and conditions for the extension workers*

It is extremely important that extension workers should be able to travel freely and quickly through the district in which they are required to work. In some cases, it may be possible for them to do this on a pedal bicycle but this is an energy-sapping and time-consuming means of transport. It is usually better to provide extension workers with motor bicycles; these are more useful than motor cars or other forms of four-wheeled transport in the isolated village conditions in which they are working. They should be taught to ride, service and maintain these.

All that has so far been said about the workers applies with equal force to their wives and families. It is important for the service to keep the wives and families happy in their isolation and arrangements should be made so that, as far as possible, they can enjoy the facilities available to the wives and families of workers at equivalent levels in the towns. Where this is impossible, an allowance should be paid.

One of the tenets which is often quoted by people discussing the organization of an extension service for agriculture, fisheries or allied industries is that the extension worker should not be burdened with any duties other than those normal to an extension service (Maunder, 1972). So far as is possible, it is certainly desirable that the extension worker should be able to concentrate full-time on his extension duties. The fisheries extension worker must be seen by the fisheries community as a friend, someone who is on their side, rather than a member of a revenue-collecting government department. Most fisheries departments have some responsibility for collecting revenue in the form of licence fees for fishing boats or gear, or both; since the officers who work in this department are seen as part of the government, they are often suspected of being in league with the tax collectors. This is another powerful reason why fisheries extension workers should be used solely as extension specialists wherever this is possible.

It must be recognized, however, that in some countries it is impossible to employ specialists for extension work because the country simply cannot afford this. In these circumstances, the fisheries assistants who have other duties, such as the collection of fisheries statistics, may also have to do the extension work. It is best, however, if licensing duties are not undertaken by these people. It is always possible to arrange for a team from regional or national headquarters to undertake licensing duties so that the extension worker is seen by the fishermen as being part of a different organization.

### *Responsibilities of the extension branch*

While the head of the fisheries department will obviously be responsible to the government for the control of the department's expenditure, the head of the fisheries extension branch should be responsible for the preparation of an annual budget for extension work and should control it. This should include capital expenditure for major items which the extension branch needs for its work, annual salaries for the staff and recurrent expenditure for purchase of minor items, travel and similar matters. This should enable the extension branch to plan its work rather more than one year ahead; indeed, the branch should normally be planning the work that it will be undertaking during the next two or three years. Similarly, the extension branch should be responsible to the head of the fisheries service for the recruitment of extension workers and for their training. The branch should not be responsible for the recruitment of specialized technologists; generally, it is better if these are recruited by the fisheries service. The extension branch should, of course, be responsible for training specialists in extension work and for the preparation of extension material.

Very few fisheries departments have arranged to give regular broadcasts to fishermen; these have generally been extremely well received and have proved very useful in circumstances where there is a considerable variation in fish prices either seasonally or from one part of a country to another. Only a very limited number of training manuals suitable for artisanal fisheries are available at present. For some of the simpler technologies, it should surely be possible to prepare suitable manuals in one of the major languages of the world which could be translated into local languages wherever they are needed. There are some difficulties in this; even the illustrations which would be needed are not necessarily universally applicable.

Finally, the extension branch should be responsible for regular reports to the head of the service indicating the progress that has been made. More important, it should perhaps be responsible for preparing an annual assessment of the effectiveness of the various aspects of the work of the extension service.

The head of the extension branch must obviously be responsible to the head of the fisheries service for the planning of future work as well as for the execution of the current programme. Equally obvious, any programme which is developed should comply with the objectives of the national development plan where one exists. However, while the head of the branch has this responsibility, he and his headquarters colleagues should not attempt to produce a master plan without consulting right down to the working level. The successful extension worker should be a self-reliant, intelligent individual who is in close contact with the people he serves. Together, they inevitably have a much clearer idea, not only of what is needed but also of what is practicable, than the headquarters staff. Planning should start 'from the bottom up'.

In consultation with the members of the community, the extension worker should plan a programme of work at least one year in advance; where problems which will obviously need a long-term solution exist, the programme may well look two or three years ahead. The programme should include possible means of solving the problem and must be agreed with the workers' superiors. They may be able to suggest alternative solutions; they must, in any case, be aware of the budget that will be needed to see the plans through and of the calls that may be made on other staff, such as specialists. The plan should include the problems which most urgently require solution but, within these, there should be a list of priorities and the worker must, of course, also be prepared to tackle unforeseen problems on an *ad hoc* basis whenever these arise.

## The work of the field staff

The work of the extension staff in an artisanal fishery is very different from the work pattern followed by the members of a university staff who undertake extension work. The university worker normally lives in a community apart from that in which the fishermen live and he is almost invariably a specialist. The extension worker in the artisanal fishery, on the other hand, is a generalist and he lives right among the people with whom he works so that he can develop an understanding of the pattern of life in the fishing community. He must learn how local conditions affect the way in which fish are caught or cultured, the way in which they are processed and marketed, and how these operations are financed. He also needs to know how profits and earnings are used. Thus, the first task of any extension worker newly appointed to a particular district must be to prepare an inventory of the capital equipment and human resources available, and the ways in which these are employed (Yaseuda, 1972).

In preparing his inventory, the extension worker should note any obvious deficiencies in the infrastructure (such as lack of berthing facilities, communications, transport and marketing facilities) as well as noting the particular skills that are present or absent in the community. He will succeed in his job only when he gains the confidence of the community in which he is working and must, therefore, be on the look-out for obvious deficiencies which can be quickly and easily remedied. Examples might include: the placing of leading marks or lights in the approach to the landing point; marking a known hazard to navigation; improving the supply of engine spares, fuel, bait, salt or ice; making dental, medical and perinatal facilities available on a regular basis; improving marketing or storage facilities. If he does find that something simple is obviously lacking, he should not proceed to make good this deficiency without consulting the community first; many communities have a pet project of their own. If the extension worker can discover what this is, and if it is practicable, then he should go ahead with this rather than attempting to introduce a project of his own. His own projects are likely to be equally or more important than the ones which the community prefer; however it is also important that the community should recognize early on that the extension service is intended to help them, not to indulge its own fancy ideas (Cole, 1975a).

### *Identification and handling of problems*

When the extension worker has obtained a good working knowledge of the pattern of life in the communities for which he is responsible, has established good working relationships with the members of the communities and has set out his inventory, he should identify (in consultation with the communities) the most important and urgent problems and should work on these. He must, of course, prepare a work plan and discuss this with his superiors. He should meet his immediate superior at least once a month, report on the previous month's work and outline his plans for the coming month. In some cases, he may be able to find solutions to local problems himself. In other cases, he will need to seek the help of colleagues or workers from other departments. Sometimes no one in government will be able to help and he must go to a commercial company for assistance. It is important, however, that problems should be reported up through the service because sometimes the answer to a particular difficulty will already be available if, for example, a solution has been found in another part of the country or elsewhere. Sometimes an answer is not readily available and research is needed to provide a solution.

The extension worker can thus be an important link between the research stations and the fishing communities. This is one of the many reasons for saying that research stations carrying out fisheries work should be under the direct control of the officer in charge of the fisheries service. It then becomes possible for the extension branch to ensure that the work which they know is needed is given proper weight in the work programme of the research stations. The immediate superiors of the field worker should require that he provides regular reports, which can conveniently be submitted verbally as well as in writing, at a monthly meeting. The reports should note progress achieved, new problems that have arisen and any other matters of interest in the area in the worker's charge. There will be failures as well as successes and the reasons for both must be assessed and analysed; the service as a whole should adopt a very flexible outlook and be prepared to modify and change its plans as this becomes desirable.

A list of national objectives is a useful guide to the individual worker; a number of districts can often work on the same aspect at one time. The provision of literature is then a simple matter and the districts can be backed up with radio or television programmes.

### *Education*

An extension programme is essentially an educational programme; the extension worker has to create situations in which others can learn and be stimulated to learn through the teaching systems (Bradfield, 1966). Since no two people have precisely the same physical or mental ability, some will learn faster than others; some will learn most easily by listening, others by seeing, doing or by discussion. Some people will need all four processes so the extension worker must be prepared to vary his approach and to use a variety of methods.

Suitable methods fall into three broad groups: those used with individuals, those used with groups and mass methods. Contacts with individuals may include home visits, office calls, casual contacts and personal letters. Home visits can be particularly useful since they provide opportunities for discussion of private problems which may not take place in other circumstances; they also give the extension worker an opportunity to meet the families, as well as the fishermen, to learn about family problems. Particular care is needed in writing letters to give advice. These should be as simple and to the point as possible and all letters must be readily understandable. Whenever possible, a suitable illustrated fact sheet or pamphlet should be sent rather than a long personal letter. Even where there is no regular postal service, it is often possible to send letters by hand through delivery men or, for instance, through fish buyers.

Once an extension worker becomes known in his district, he can expect to do much useful work by means of casual contacts made in such places as fish markets, gear supply shops, boat yards or even by visiting fishing villages. Fishermen who do not come to his office or who cannot write will contact him informally in this way and he should treat these approaches just as seriously as the more formal ones.

Proper detailed records should be kept of all individual contacts; reference to these records would tell the extension worker, or his successors, all that they need to know about a particular fisherman, his way of life, his methods and problems, what has already been done to help him and the results. It is vitally important that any promises made during these contacts are kept. If an extension worker promises to send written advice, or to make a contact on someone else's behalf, or to obtain advice for him, he must carry out his promise. Every extension worker should keep a detailed diary in which he records daily all contacts and promises made besides his other activities. The diary is an official document and should be kept in such a form that it will be useful, and available, to his superiors and his successors.

Chambers (1974) suggests that agricultural extension workers should issue notebooks, in which they record notes of their visits, to the farmers in their district. This has the twofold advantage of enabling superiors to check on the number of visits made to individual farmers and of providing a means by which any advice given can be left with the farmer. As far as I am aware, no fisheries extension service has ever done this but there are obviously some situations in which it might be useful. It might not be necessary to issue notebooks to individuals, these might be left with village headmen and then serve just as useful a purpose as if issued to individuals.

Group methods generally require even more careful planning than individual contacts. They may include meetings on a village (or larger) scale, demonstrations of methods or results, visits to other villages or fish landings and participation in shows. Group meetings are particularly useful in developing countries. They should be treated as opportunities for discussion rather than as lectures; the people, more particularly the leaders, should be fully involved and encouraged to take active roles.

Fishermen are accustomed to learning by 'method demonstrations' since this is the way in which fathers teach sons to fish. Subjects which would best be taught in this way include net making and hanging, net repair, new methods or variations in old methods of handling, processing and preservation (such as salting, smoking and drying, icing fish), manufacture of fish boxes and smoking kilns; all the usual practical skills.

'Result demonstrations' differ only in that they go a step further and show what happens as a result of varying or carrying out a particular process (for instance, that by hanging a net to the correct length you catch more fish: that properly iced fish keeps longer than poorly iced fish; that well-made smoked fish looks and tastes better and keeps longer than poorly made smoked fish; that by doing it the new way, you can show a bigger profit for your labours). The essence is to compare two or more procedures.

Visits should be made when some parts of the country are carrying out advanced techniques that are not used in other parts. They are then especially useful since the visitors can imagine for themselves what conditions were like before the changes were made and can see the advantages of making the changes. It would obviously be very difficult to reach all members of the fishing communities and, when new laws are enacted, fish prices changed or new methods prove outstandingly successful, then the mass media and other mass methods should be used. Newspapers, magazines and television cannot be used to reach all developing country fishermen; methods which can be used include radios (fishermen often sit mending their nets beside transistor radios), posters and handouts. Such material should be prepared for the extension service as a whole rather than by the individual extension worker.

As with any other educational programme, it is necessary to check the progress being made and to evaluate results. This is more difficult with extension programmes than with any others because the students and teachers meet at undefined times in a variety of different places. None the less, an attempt must be made or no one will know whether or not the service is succeeding in its objectives. In most countries, it would be difficult, if not impossible, to attempt to use even moderately sophisticated methods of evaluation, such as systematic formal enquiries by teams of trained research workers; much simpler methods are needed, particularly when dealing with illiterate or semi-literate people.

Effective checks on progress are made by requiring extension workers to submit regular reports in which they detail what they have done, where they have been and what they think the results have been, not only for the current period of work but also for work done in the past. These reports are best presented verbally with accompanying notes at a regular meeting with the individual extension worker's immediate superiors. Every extension worker should of course have a clear, planned programme showing exactly what he is going to do during the year and, in particular, what points he is trying to convey to the fishermen or their families. This gives the individual workers confidence and makes it easier to check on the effectiveness of their programme. The extension programme is really aiming to change the attitudes of people in the fishing villages; even in the best circumstances, it is difficult to make other than a purely subjective evaluation of this.

### Liaison

Advice about the technologies involved in fishing and fish handling will almost invariably be available within the fisheries department. However, not all fisheries departments are able to advise on matters such as boat construction and, in most countries, there are specialized departments which deal with the marketing of agricultural and fisheries products and with the formation and operation of co-operative societies. Many of the projects with which an extension worker will be involved require that capital be provided from outside the immediate area in which he is working, often by the national government. Sometimes, the running costs for some of his projects will be provided in the same way. Often, fishermen or their families need advice on the care of their animals and on growing their crops, fruit, coconut trees or vegetables. Where major public works, such as roads or bridges, are required, the public works department or its equivalent will be involved. In medical matters, workers at the ministry of health will be required.

Clearly the people needed, some of them fairly senior in government service, will not 'come-a-running' when the extension worker, who is comparatively junior, whistles. Indeed, officers of other departments often show a marked reluctance to appear in fishing villages at all. When they do appear, their visit is often so brief that the dust raised by their arrival still hangs in the air as they make their departure. It is necessary to evolve a method of working, which will ensure that the fisheries extension worker is able to obtain the advice and assistance he needs from other departments and to integrate the efforts being made by the various government departments to develop a particular area.

## Management

In recent years, a variety of different methods of providing for the integration of development have been tried in different parts of the world. Chambers (1974) provides a very valuable review of the management of rural development based on ideas and experience obtained in East Africa. The methodology recommended by Chambers is based on what he called the 'programming and implementation management (PIM) system' which was developed in Kenya from 1971 onwards. According to Chambers the PIM system has three main components:

(1) A programming exercise, which was annual and held just before or after the beginning of the financial year. This is a meeting, attended by all those directly concerned with implementation, at which they jointly and freely draw up a phased work programme for the year.

(2) A management meeting, which was usually monthly. At this meeting attended by those concerned directly with implementation, progress is reviewed against the phased work programme, bottle necks are identified and remedial action agreed upon.

(3) An action report, which was described as a monthly management report, summarizing briefly the progress made and problems encountered, naming those responsible for action, and sent quickly and simultaneously to those concerned at different levels in Government.

Anyone concerned with rural development would find Chambers' exposition of great value. In some situations, it is possible to hold regular meetings attended by all departments involved in rural development but the group meeting must be small or it degenerates from a 'workshop' to a 'talk shop'.

A similar system was evolved in Malaysia in the 1950's and 1960's which suggests that a system of this kind can be made to work under widely differing conditions. Like everyone else who has been intimately involved in the development process, Chambers is insistent that the people who are being helped should be intimately involved at every stage of the process and their thoughts and ideas should be incorporated in any programme which is developed. Development must come from 'the bottom up' not from 'the top down'.

## Training for extension workers

In Europe and North America, the people who carry out extension work in the field are often university graduates. Such people are seldom broadly trained generalists; usually they are specialists and, in some cases, so highly specialized that they may be responsible, for example, for quality control aspects of fish processing rather than working in fish handling generally. These people could of course be very useful in the development of an artisanal fishery; unfortunately, they are far too expensive to be employed in these situations. In the developing world, the fisheries extension worker should be a well trained technician who has a good understanding of a number of different technologies including boat-building and maintenance, fishing gear maintenance, and fish handling, processing and marketing, among other subjects. In most territories which were formerly under British control, three levels of grading in the government service are recognized: the more senior posts, filled by university graduates; the middle level posts, filled by diploma holders who have attended a 3 year course of instruction following secondary school; and the more junior posts, filled by certificate holders who have attended a 2 year course of instruction following secondary school. Cole and Hall (1973) discuss job specifications and standards of proficiency in considerable detail. The fisheries extension worker would normally be a certificate holder, his immediate superior a diplomate while the more senior officers in a fisheries department are usually graduates.

Cole and Hall, in 1973, set out in their Curriculum No 39 'Fisheries Assistants' the training syllabus used for Fisheries Assistants in Uganda. The course was designed for people who would be working in freshwater fisheries and needs modification for people working in marine fisheries in other parts of the world. In addition to the basic science, mathematics and technology set out in this course, a student who is to work as a fisheries extension officer needs training in the principles of adult education and mass communication, and the management and operation of fisheries co-operative societies. Cole (1975b) suggests a curriculum for use in Nigeria for training extension workers during a 2 year certificate course; unlike the one for Uganda, it is not yet in operation.

Any course of this type needs to include subjects such as basic sciences and mathematics, statistics, fisheries co-operative societies, principles of adult education and mass communication, ecology, fisheries biology and aquatic sciences, fish handling, preservation, processing and marketing, fisheries management, fish culture, fishing gear technology, navigation and seamanship. It is also very important that students should be taught to write clearly and concisely; they should be given plenty of practice in this and in taking part in and controlling meetings, delivering lectures and carrying out demonstrations. In general, the aim should be to arrange the course so that at least half the student's time is spent in practical work.

In some countries, students are selected for a 3 year diploma course rather than a 2 year certificate course at the time they leave school. Since this frequently results in the training of people who then prove unsuitable for the type of work they are expected to do, it seems to be much more sensible to arrange that new recruits to the fisheries department work for at least several months in the field before they undergo any training at all. They should then attend a 2 year certificate course before returning to the field; only those who have passed the 2 year course satisfactorily and have then proved themselves useful in the field should be selected for a third year of training leading to a diploma and, in most cases, to immediate promotion. No one should fill, or attempt to fill, a supervisory role in a fishery extension service unless he has himself worked at the most basic field level.

## References

**Bradfield, D. J.** (1966) *Guide to extension training.* Rome: FAO.

**Chambers, R.** (1974) *Managing rural development.* Uppsala: Scandinavian Institute of Management Studies.

**Cole, R. C.** (1973) *Report on fisheries development and requirements of fishery education and training in Malaysia, Thailand, Fiji and The Philippines,* Rome: FAO.

**Cole, R. C.** (1975a) *Fisheries education and training, Zambia,* Rome: FAO, FI:DPZAM/73/009/1.

**Cole, R. C.** (1975b) *Report of the FAO Mission to Nigeria to determine the needs for training in inland fisheries and wild life management. Part 1 Inland Fisheries.* Rome: FAO.

**Cole, R. C. & Hall, D. N. F.** (1973) *Guide to fishery education and training.* Rome: FAO.

**James, D.** (1977) Fish processing and marketing in the tropics: restrictions to development. In: *Proc. Conf. handl. proc. mark. trop. fish., London,* 5–9 July 1976. London: Tropical Products Institute.

**Lawson, R. M.** (1972) *Report on credit for artisanal fishermen in South-East Asia.* Rome: FAO.

**Maunder, A. H.** (1972) *Agricultural extension: a reference manual.* Rome: FAO.

**Yaseuda, T.** (1972) *Fisheries extension service.* Rome: FAO. FIE:FET/73/BP 3.

# Small-scale fisheries development

**D. G. James**
Department of Fisheries, FAO, Rome

### Summary

This paper outlines FAO progress and plans in helping to develop small-scale fisheries. It summarizes the scope of the present and proposed field programme and stresses the need for a unified, vigorous approach in enlisting support for further development. It also indicates the present thinking of conceptual matters to be tackled in order to make assistance programmes more effective.

### Résumé

Cet article esquisse les progrès et projets de la FAO pour l'aide au développement des petites entreprises de pêche. Il résume l'entendue du programme actuel et du programme proposé et insiste sur les besoins d'une approche unifiée et énergique pour obtenir de l'aide pour un développement ultérieur. Il indique également les notions actuelles concernant le dessein des projets d'aide et la façon de les rendre plus efficaces.

### Resumen

Este artículo señala los progresos y planes de la FAO para ayudar al desarrollo de las pesquerías a pequeña escala. Resume los objetivos del programa actual y propuesto y acentúa la necesidad de un avance firme y unificado para conseguir apoyo para un mayor desarrollo. Se indica también la línea de pensamiento actual a seguir con objeto de hacer los programas de asistencia más efectivos.

## Introduction

It is generally recognized that there are serious socio-economic problems in the small-scale fishery sector. The report of the Ninth Session of the Committee on Fisheries (COFI) held in October 1974 commented as follows on the subject:

> '. . . small-scale fisheries are a source of vital protein food supplies and provide employment for a large labour force. The Committee reiterates its concern about the slow economic and social progress in this sector in developing countries. In spite of many efforts to improve the state of small-scale fisheries, the people engaged in these activities and their families continue to live at the margin of subsistence and human dignity. The problem is of such magnitude that development assistance programmes ought to give the highest priority to finding solutions for improving these fisheries and allocating the necessary funds for the implementation of action projects. The Committee fully recognizes the complexity of the problem, the solution of which not only requires technological and scientific inputs but calls for an overall approach with due regard for social, economic, cultural and political aspects . . .'

The Department of Fisheries is intensifying its work on small-scale fisheries to give effect to the recommendations of the Committee of Fisheries that FAO should pay greater attention to this sector. Specifically, the Committee suggested that FAO should develop (1) regional and sub-regional programmes of pilot operations and model projects and (2) global concepts and guidelines for small-scale fishery development.

This paper describes progress made to date and sets out plans for further FAO activities in this field.

## The role of FAO

The problems facing small-scale fisheries are so many and so complex that there can be no hope for very substantial changes for the better in the short term.

The road to success is likely to be long and difficult. Although FAO and others have provided development assistance for many years, it is questionable whether a great deal has been achieved so far in most parts of the world. Lack of progress is generally attributed to the piecemeal approach that has been used in tackling the problems of the sector and it is agreed, therefore, that there can be no hope of making substantial improvements until an integrated approach to the solution of the various problems is adopted.

One significant feature of FAO's new programme in small-scale fisheries is a change in emphasis with regard to development objectives. Although fishing is the main livelihood of the people concerned, increasing their production of fish may not be the primary objective of development. The poor fishermen and the other elements in the small-scale sector generally lack education, capital and other requisites for taking advantage of newly created opportunities to expand their operations; often only those who are already comparatively well off are assisted by the introduction of improved technology. The primary development objective in the small-scale fisheries sector, therefore, must be to improve the material and social welfare of the poor fishing communities. Furthermore, it is generally agreed that small-scale fisheries must be developed as part of an overall rural development effort.

It must be realized, however, that FAO and its subsidiary bodies can only identify problems and assist developing countries in searching for solutions; how much is actually achieved will depend on subsequent action at the national level. The FAO Field Programme, financed by UNDP and other extra-budgetary funds, is providing resources for experimental and demonstration work to pave the way for broader follow up by the nations concerned. However, externally financed pilot projects and demonstration schemes will have only a very slight effect, or none at all, unless they include specific provisions for transferring experience and know-how. In each country, furthermore, development resources must be effectively mobilized at all levels, from the top planning departments down to the village fishermen, if significant progress is to be achieved.

To ensure that experience gained in some countries and regions can be usefully applied elsewhere, national systems for collecting and disseminating information must be improved and the different national programmes of information assembly must be better co-ordinated. These are traditional FAO functions but FAO Regular Programme funds are clearly inadequate to accomplish this effectively; the activities, therefore, must be supported by extra-budgetary funds.

### *Field programmes*

For the most part, FAO small-scale fishery projects have been of rather short duration. Only very rarely have the problems of the sector been viewed in an integrated fashion at inception. Too often the projects came into being without adequate planning and without the conduct of preliminary feasibility work. There are many reasons for this, including those of humanitarian nature, also, preconceived ideas of those who formulated the projects; over-emphasis on the solution of technical problems; reluctance of donor agencies to commit funds for long-term or open-ended projects; lack of information; and failure, in some cases, of the countries concerned to have drawn up overall and sectoral development programmes.

The regional and sub-regional projects, which the Ninth Session of the Committee on Fisheries had urged FAO to establish (and which would include pilot operations and model projects and make it possible in time to develop global concepts and policy guidelines), are currently being formulated and/or submitted to funding agencies. A preparatory regional project has been in operation since last year in West Asia; plans for further projects have been drawn up for South America, the Western Pacific, SE Asia, the Near East, East Africa, inland Africa, Central America and the Caribbean. The objectives are to consolidate knowledge and information on small-scale fisheries, improve programme and project planning and formulation, and mobilize development resources from various support agencies. The specific objectives and activities of the different regional projects will differ from one region to another but the main objectives they will have in common will be to:

(1) Provide a data base, quantify the problems to be tackled, to permit programming at some future date.

(2) Identify and, as far as possible, quantify specific needs at the national and regional levels.

(3) Review and evaluate previous and present assistance schemes.

(4) Formulate an assistance programme for tackling high priority problems of common concern in the region and prepare separate projects with emphasis on continuing and multiplier effects.

Subsidiary objectives of significance will be to promote support for additional assistance to the sector, to increase the awareness of small-scale fisheries problems among fishery administrators and government planners, and give direct assistance to current planning efforts through workshops.

Each of the regional projects will feature a workshop for fishery administrators and government planners concerned with small-scale fishery development. These workshops will cover all aspects of the subject, with particular emphasis on planning and formulation of development programmes. The planning exercise will concentrate on the assessment of potential and limitations, taking into account the fishing resource situation and government objectives and policies on employment, income, nutrition etc. An effort will be made to select high-impact areas and to determine what is needed, in technical and economic terms, for preparing and carrying out development programmes and projects. The material emerging from these workshops will be used in drawing up a programme for a World Technical Conference on Small-scale Fisheries, the organization of which was supported by the Ninth Session of the Committee on Fisheries.

The World Conference is to be organized under a global programme which is to be developed on the basis of the regional activities described above. As envisaged now, this global programme will have two phases.

The preparatory phase will be concerned with co-ordinating support and planning services necessary for a long-term programme of integrated development of small-scale fisheries in developing countries. Under this phase, a data centre for work on small-scale fisheries will be established. In addition, detailed plans for the preparation and conduct of the World Conference on Small-scale Fisheries to be held at the end of this phase will be drawn up. Other activities will be concerned with the promotion of international co-operation in small-scale fisheries development and the mobilization of increased technical and financial assistance for this purpose.

The larger-scale, second phase project will, *inter alia*, include the following types of activities: expansion and promotion of the use of the centralized data system on small-scale fisheries; collaboration with regional development banks and other funding agencies with a view to attracting funds both for social investment needs as well as for physical infrastructure, equipment and technology; introduction of adaptive or innovative technologies to assist in overcoming universal problems encountered by small-scale fisheries etc.

The FAO Field Programme is heavily reliant on support from UNDP (the various projects are listed in Appendix 1). The severe budgetary difficulties of the Programme since late 1975, therefore, have not only led to a moratorium on the implementation of projects that had already been approved in principle but have also necessitated a curtailment of projects which were already operational. New sources of funding must be found if efforts in this sphere are not to 'bog down' seriously. National funding agencies are increasing their assistance programmes in co-operation with FAO. The support from this side is still relatively small but opportunities would seem good for a fair-sized expansion. Efforts will be made, in particular, to attract more funds from these bi-lateral sources for support of FAO's small-scale fishery programme.

### *Elaboration of a general approach*

Among the tasks which the Department of Fisheries plans to undertake in the immediate future under its Regular Programme is the further refinement of an FAO policy and strategy on small-scale fisheries procedures. This work is to be followed by the preparation of a series of guidelines and manuals; these will cover development concepts of a social, economic and technical nature as well as considerations in the planning, formulation and implementation of small-scale fisheries development programmes. It is expected that, before long, a consolidated view of the principal problem areas to be tackled will emerge and that this will help in establishing priorities for action to be undertaken as the necessary funds become available.

An informal 'Think Tank', the findings of which are detailed further on, was organized in September 1975 to facilitate this work. Also, a number of experts from both developed and developing countries were invited to participate, together with FAO specialists, in a workshop organized by the South Pacific Commission in November 1975. In addition, OECD organized a special meeting on the subject late in 1975, and a World Conference on Co-operative Fisheries, organized by the ICA in early October 1975, went into certain aspects of small-scale fisheries development. The present Conference which has been convened by the Tropical Products Institute of the United Kingdom is the latest effort to take up small-scale fisheries problems in an international forum.

While working out concepts and guidelines is traditionally regarded as a Regular Programme activity at FAO, the feedback from the Field Programme is vital to success. It is essential that a central point should have responsibility for co-ordination, the standard evaluation of progress and future programming. FAO, therefore, hopes to enlist the support of UNDP and others to setup the previously mentioned global project to deal with these matters.

The frame for the conceptual work for small-scale fisheries development is not yet completed but the following social, economic, technical and organizational considerations are likely to be of general application and importance. The relative importance of these aspects may vary from one country or region to another and much additional research will have to be carried out before any order of priorities can be established.

*Social considerations:* The key to self-sustained development is the active participation and personal involvement of beneficiaries of any development scheme in all aspects of the work. Economic and technical feasibility of assistance projects is usually carefully investigated while social feasibility, which is as important as the other aspects, is taken for granted or simply neglected in the preliminary investigations. Generally, the only constraint considered and analysed in this sphere is lack of skill and education while little or no attention is given to the social environment into which the development efforts have to fit. Political, religious and national background factors have an important bearing on work motivation, organizational and managerial structures, distribution of income and ownership patterns (factors which, by the way, must be studied specifically in the context of small-scale fisheries). A special issue that has to be examined is to what degree a fishery project in the small-scale sector can be integrated with rural development activities in general.

*Economic considerations:* Assistance programmes and projects should be selected and evaluated on the basis of established economic criteria. The financial criteria applied in business are inadequate, and even unsuitable, for the evaluation of rural development projects. Social costing techniques are rapidly gaining acceptance but there is still a wide gap between theory and practice in their actual employment in development planning.
For fisheries, in particular, they have only rarely been applied. More work is needed on the methodology of applying them in a given situation before the techniques will become a meaningful tool in the evaluation process.

Another consideration related to economics is that of financing and credit. A review of past experience in financing small-scale fisheries operations would probably show that there have been more failures than successes in this field. It is thought that such a review would provide a good basis for a thorough examination of the problems that must be taken into account in future planning.

*Technical considerations:* Much more is known on these aspects of the problem than, for example, on sociological and economic aspects. Most assistance activities have focused on the techniques of fishing, boatbuilding, distribution and marketing, and notable successes have been achieved in these fields. The type of technical assistance usually provided has, however, some shortcomings: the techniques introduced are often too advanced for the beneficiaries and cannot be easily adapted to local conditions; too little time is allowed to complete the transfer of technology; too little consideration is given to temporary adverse effects of the introduction of new technology on employment, patterns of living etc and to supplementary assistance to ensure integrated development. In this connection, it would seem that systematic analysis of experience from different projects in different regions would tend to be of great value for future project formulation.

Another aspect, which requires much more attention in planning assistance projects than it has been accorded hitherto, is the employment of low-level technology which is labour-intensive and saves foreign exchange. Innovations and new methods are needed to permit the maximum possible use of locally available materials and skills. Therefore, in some situations, to economize and to provide work, locally constructed fishing boats propelled by sail might be employed rather than imported fibreglass boats with outboard engines.

*Organizational considerations:* Under this heading, a variety of issues of relevance to the planning, formulation and implementation of programmes and projects may be grouped.

At the macro-level, there is the problem of the role and place of small-scale fisheries in the fisheries sector, which has to be solved within the framework of a master plan. Since the planning is usually dictated by political and macro-economic concerns, the particular problems of fisheries are often not properly taken into account. For fishery development planning, location and abundance of fishery resources are of over-riding importance as are such other matters as physical conditions along the coastline, which are of decisive influence in the choice of location for landing facilities. Generally, there is also a problem of co-ordination with other sectors of the economy, such as agriculture. The latter type of co-ordination is, of course, of special importance in rurual development programmes. Another issue that has to be carefully considered in planning is that of the provision of supporting government services and of an adequate institutional structure.

At the micro-level, ie the level of design and implementation of projects, the following issues appear to be of principal consequence:

(a) Regional projects: are regional pilot and model projects feasible and, if so, what types of project?

(b) Dissemination of information: how can findings and achievements be transferred from one project in a country or region to another?

(c) Phasing: should projects be designed on an open-ended basis, with moderate starting input and a gradual build-up, or should they be for a fixed term with precise objectives (the latter is the approach commonly used at present)? What is an appropriate project duration for different types of projects?

(d) Equipment and facilities versus experts: is there an alternative to the present system of relying on international expertise, which is becoming increasingly expensive and difficult to obtain? What would appear to be a reasonable combination, in the design of projects, of equipment facilities and experts?

Circumstances in a given case are likely to have a substantial bearing on the answers to these questions. It must be remembered, however, that the purpose of the conceptual work is not to produce generally applicable solutions but to provide tools for development workers to enable them to improve their performance.

### Expert Consultation on Small-scale Fisheries Development

The technical, social, economic and planning requirements for the preparation and implementation of small-scale fisheries development projects and programmes have been developed further at the "Think Tank" meeting organized by FAO in September 1975; the meeting also touched on matters of general policy and strategy to be adopted for development of this sector.

#### *Principal development considerations*

The following were among the specific conclusions on principal development considerations arrived at by the group of experts in the course of their five day discussions:

*Resource assessment and monitoring:* Ongoing monitoring and application of broad experience from similar fisheries will help to avoid over-investment in new and developing fisheries. Since regulations for conserving small-scale fisheries are difficult to apply, stock assessment should usually be used to determine the fishing units or the number of men who should be engaged in a fishery.

*Vessels and gear:* Step-by-step improvement of existing vessels in design and use of new material etc is a better approach than introduction of radical changes. Local skills in boatbuilding, and in gear and equipment making, and local materials should be used as much as possible in development projects (with training provided to upgrade the production) to promote industrial development and increased employment.

*Land facilities:* The cost of harbour construction is usually very high but effective beach landing facilities can sometimes be established at a reasonable cost. These facilities should be located, if possible, where they serve several fishing communities.

*Technology and marketing:* Preservation and processing techniques introduced should be within the technical ability and economic capacity of the operators. Possibilities of employing sources of low-cost energy (sun, wind and waste heat) should be investigated. Governments should provide the funds and ensure technical training and support by establishing effective extension services in the fish handling, processing and marketing sphere.

*Provision of credits and organization structures in fishing communities:* Co-operatives appeared to offer the best means for assisting fishermen not only in obtaining required credit on favourable terms but also for making progress generally in the development of fisheries. The co-operatives should be 'multipurpose' in character; they should be involved in supporting all the main activities of the fishermen. They must be staffed by a trained manager and skilled personnel, and run on business lines; they must also be allowed to operate free from political or other outside interference. The fishermen must be persuaded to sell their fish through their co-operative; this allows the latter to subtract loan instalments due from the proceeds of the sale of the fish and, therefore, ensure the repayment of loans. While co-operatives offer the best future for the fishermen, efforts to improve the traditional fisherman/trader system should continue to obtain a fairer deal for the fishermen.

*Training:* Governments should expand extension services and upgrade extension worker training. More emphasis should be placed on practical training so that the extension officers can work closely with the fishermen and fishing communities and demonstrate improved gear, equipment, machinery and techniques. Community centres should be set up to give special training to selected fishermen and other elements in the villages to raise actual or potential leaders to a level that would enable them to spread knowledge and understanding of development objectives.

*Institutional framework:* Governments should provide funds and other support for the establishment of fishery institutions required for developing the small-scale fisheries sector. They should abolish, or modify, laws and regulations which tend to restrict small-scale fisheries development.

*Issues related to economics:* Recognition should be given to the dominant place of social and human values in justification of development projects for small-scale fisheries. Efforts should be made to adopt, or adapt, improved techniques which are being employed in other sectors of the economy, particularly in agriculture.

*Social issues:* The fishermen and fishing communities should be, from their inception, intimately involved in projects designed for their benefit. The community should be fully aware of development needs and should be willing to participate in surveys relating to existing conditions and progress in operations. For the success of projects, it is imperative that culture, customs, habits etc are fully understood.

*Objectives and planning:* All proposals regarding fishery policy, objectives and targets should be carefully examined to study their relevance to programmes for small-scale fisheries development. To the extent possible, relations on the input and output side, as well as between inputs and outputs, should be quantified. Feasibility studies and models should be prepared wherever possible to indicate likely consequences of alternative proposals. Jurisdictional responsibilities should be clarified and only one ministry should be given responsibility for putting adopted policies into effect.

### *Principal guidelines*

The principal guidelines which emerged from the meeting were summarized in the following points:

(a) A basic prerequisite for the execution of a small-scale fisheries development programme is evidence of government support and interest in the sector. This should be demonstrated by a declaration of policy, provision of funds, counterpart staff and all other required inputs, and the removal of legal and other constraints which are obstacles to development.

(b) Another essential requirement at the planning stage is to find out and take into account the hopes, needs and aspirations of the fishermen and their communities and to ensure that they understand and agree with the objectives of the project and become fully involved in it.

(c) Due to the critical importance of extension services, there must be agreement to increase the number of workers and raise their standard of training.

(d) The development process must be conceived in terms of a step-by-step approach, not a revolutionary change. The effort must be to harmonize what is being carried out with traditional patterns and customs. The fullest use should be made out of local skills, industry and materials.

### *The contribution of FAO*

The meeting finally also discussed the contribution which FAO might be able to make in the implementation of small-scale fisheries programmes. Its conclusions on this point of the agenda were as follows.

FAO's role depends to a large extent on, and is certainly influenced by, a government's policy commitment (in terms of funds, staff and all other required inputs) to the development of its small-scale fisheries. Indeed, this commitment is so critical that the meeting expressed the view that FAO should concentrate its efforts on projects and programmes in those countries where the governments have not only made such a commitment but have also provided the funds and inputs and have started to implement the plans.

Reference was made to FAO's new regional and sub-regional projects which, in their opening phases, are intended to lead to identification of needed projects and programmes in the development of small-scale fisheries; they are designed to 'fill the gaps' in national development efforts and, thus, help to bring about a more integrated development effort as a whole.

FAO still has a major job to do as a clearing house of information and, in this connection, the meeting urged an increase in the number of technical papers, reports, instructional books, training manuals etc and special efforts to have them more widely distributed, particularly among field staff in developing countries.

It was further concluded that the Organization should try to persuade universities, technical institutions and research centres, especially those in developing countries, to concentrate more on the problems of development in small-scale fisheries. The research in this field should be focused more sharply on practical problems and issues.

The proposal that FAO organize technical workshops on the problems of development of small-scale fisheries on a regional basis was strongly endorsed. The workshops should be multi-disciplinary and each should be tailored to deal with the specific problems of a region. The meeting was also of the opinion that, at a later stage, a technical conference on the problems of development of small-scale fisheries could be organized; this would serve to cast a light on the global situation of small-scale fisheries, provide an informative picture of the development scene and put future development needs into sharp focus.

Other discussions of the problems of small-scale fisheries development which have taken place, in recent months, at the international or regional level are summarized below.

### International Conference on Co-operative Fisheries

At this conference in Tokyo (29 September to 3 October 1975), attention was focused on the important role of co-operative societies in small-scale fisheries development. Another subject was taken up during the discussion of the agenda item concerned with small-scale fisheries; this was a sequential procedure for promoting an integrated development approach. This involved (as the needs for such activities arise) creation of employment-generating development work with a high labour content; organization of community facilities; establishment of small-scale, labour-using industries (eg through backward and forward linkages in the fisheries sector); introduction of financial self-help schemes etc.

### OECD Committee for Fisheries

At the 36th session of this Committee, held in Paris (23 to 29 September 1975), the discussion of problems and policies related to small-scale fisheries touched on those problems commonly experienced in the development of the small-scale fisheries sector. Constraints in the spheres of marketing, labour force procurement, capital expenditure trends, fishery resources scarcity and high production costs were covered in some detail. Mention was made of the shift in emphasis in technical assistance programmes from the support of large-scale, capital-intensive to small-scale, labour-intensive ventures. The need for assessing economic viability of assistance projects designed to provide help for long-term small-scale fisheries development programmes was stressed. Well planned and well run 'on site' demonstration projects were also considered essential components of these programmes.

## APPENDIX 1

### FAO field projects in the small-scale fishery category

| *Location* | *Duration (years)* | *NTE* | *Expert m/m* | *International contribution (US $)* | *Funding source* |
|---|---|---|---|---|---|
| AFRICA | | | | | |
| *West Africa – Marine* | | | | | |
| Benin: modernization of artisanal fishery | 1 | 1977 | 20 | 180,000 | UNDP |
| Gambia: inshore fisheries | 3 | 1976 | 76 | 312,974 | UNDP |
| Ghana: fisheries development | 4.5 | 1976 | 137 | 709,078 | UNDP |
| Guinea: marine fishery development | 4 | 1978 | 192 | 1,477,200 | UNDP |
| Guinea: motorization of canoes | 1 | 1978 | – | 967,800 | CIDA |
| Nigeria: co-operative organization | 6.5 | 1978 | 74 | 416,477 | UNDP |
| Senegal: artisanal fishery development | 2.5 | 1977 | 89 | 359,200 | UNDP |
| Senegal: artisanal fishery development expert and vocational training centre (ILO project) | 2 | 1977 | 20 | 100,000 | UNDP |
| | | | *Sub-total operational US $* | *4,522,729* | |

| Location | Duration (years) | NTE | Expert m/m | International contribution (US $) | Funding source |
|---|---|---|---|---|---|
| *Pipeline projects* | | | | | |
| Cameroon: artisanal fishery development | | | | 500,000 | UNDP |
| Congo: artisanal fishery development | | | | 745,000 | |
| Gabon: fishery development | 5 | 1981 | 160 | 678,500 | |
| Nigeria: canal fishery development (two projects) | | | | 170,000 | |
| Nigeria: development of extreme shallow draught vessels | 2 | | | 250,000 | |
| | | | *Sub-total pipeline US $* | *2,343,500* | |
| *Africa – Inland* | | | | | |
| Regional – Lake Chad preparatory project | 4 | 1978 | 196.5 | 1,412,680 | UNDP |
| Regional – Lake Tanganyika: preparatory mission | – | 1967 | – | 30,000 | SIDA |
| Burundi – Lake Tanganyika: fishing centre development | 3 | 1976 | 88 | 725,000 | UNDP |
| Ivory Coast – Lake Kossou: fishery development | 4 | 1975 | 175 | 836,000 | UNDP |
| Malawi: fishery development | 4 | 1976 | 402 | 1,473,000 | UNDP |
| Malawi: fishermen's training | 4 | 1976 | 58 | 395,000 | DANIDA |
| Nigeria – Lake Chad: fishery development | 4 | 1978 | 231 | 735,000 | UNDP |
| Sudan – southern region: preparatory assistance | 2 | 1975 | 24 | 73,000 | UNDP |
| Sudan – southern region: interim training | 1.5 | 1972 | 60 | 376,000 | UNDP |
| Tanzania – Lake Tanganyika: fishery development | 5 | 1977 | 315 | 1,424,000 | UNDP |
| Zambia: fishery development | 2 | 1975 | 111 | 373,000 | UNDP |
| | | | *Sub-total operational US $* | *7,852,680* | |
| *Pipeline projects* | | | | | |
| Kenya: fishery development on Lake Victoria | | | | 400,000 | UNDP |
| Malawi: fishery development | | | | 1,500,000 | UNDP |
| Nigeria: inland fishery training | | | | 500,000 | NIR and UNDP |
| Sudan: regional training centre | | | | 727,000 | DANIDA |
| Uganda: fishery development | | | | 750,000 | UNDP |
| Zambia: construction of fishing boats | | | | 182,000 | NORAD |
| | | | *Sub-total pipeline US $* | *4,059,000* | |
| *East Africa – Marine* | | | | | |
| Comoro Islands: artisanal fishing | 2 | 1976 | 25 | 100,000 | UNDP |
| Ethiopia: equipment | 2 | 1976 | | 105,000 | FFHC |
| Somalia: small-boat fishery development | 3 | 1977 | 158 | 691,000 | UNDP |
| | | | *Sub-total operational US $* | *896,000* | |
| *Pipeline projects* | | | | | |
| Ethiopia: artisanal fishery development (two projects) | | | | 1,664,000 | UNDP |
| Kenya: mechanization of coastal fishery | | | | 850,000 | UNDP |
| | | | *Sub-total pipeline US $* | *2,514,000* | |
| *North Africa and Near East* | | | | | |
| Yemen (A.R.): artisanal fishery development | 4 | 1970 | 345 | 1,857,000 | UNDP |
| | | | *Sub-total operational US $* | *1,857,000* | |
| ASIA AND THE FAR EAST | | | | | |
| *Indian Ocean* | | | | | |
| Regional – West Asia: preparatory projects for development of small-scale fisheries | 2 | 1977 | 89 | 458,900 | UNDP |
| Bangladesh: projects for training of extension workers | 1 | 1976 | 19 | 57,000 | NORAD |
| | | | *Sub-total operational US $* | *515,900* | |
| *Pipeline projects* | | | | | |
| Indian Ocean region: accelerated development of artisanal fisheries | | | | 5,446,940 | CIDA 1/CAN/23 |
| Regional – Bay of Bengal: fishing community development | | | | 4,150,000 | SIDA |
| | | | *Sub-total pipeline US $* | *9,616,940* | |

| Location | Duration (years) | NTE | Expert m/m | International contribution (US $) | Funding source |
|---|---|---|---|---|---|
| *South China Sea and Pacific* | | | | | |
| Cook Islands: fishing demonstration and long-range development planning | 2 | 1977 | 32 | 99,000 | UNDP |
| Western Samoa: fishery adviser | 2 | 1976 | 24 | 110,800 | UNDP |
| Western Samoa | 2 | 1978 | | 409,000 | DANIDA |
| | | *Sub-total operational US $* | | *363,800* | |
| *Pipeline projects* | | | | | |
| Regional – Pacific: fishing demonstration and long-range development planning | 3 | | 187 | 1,228,000 | UNDP |
| Regional – S E Asia: preparatory project | | | | 154,000 | UNDP |
| | | *Sub-total pipeline US $* | | *1,382,000* | |
| LATIN AMERICA | | | | | |
| Regional: preparatory projection small-scale | 1 | 1976 | 22 | 80,000 | UNDP |
| Belize: expert advice (technical) | – | 1975 | 6 | 23,000 | UNDP |
| Dominican Republic: purchase of equipment | – | 1974 | – | 10,000 | FFHC |
| Guatemala: fishing demonstration and co-operative organization | 2 | 1977 | 64 | 262,000 | UNDP |
| Panama: artisanal fishery development | 2 | 1976 | 113 | 524,000 | UNDP |
| Turks and Caicos Islands: boatbuilding | 0.5 | 1975 | 6 | 15,000 | UNDP |
| Uruguay: equipment and supplies for co-operatives | – | 1976 | – | 126,000 | FFHC |
| | | *Sub-total operational US $* | | *1,040,000* | |

| | *Operational US $* | *Pipeline US $* |
|---|---|---|
| Africa and Near East | 15,128,409 | 8,916,500 |
| Asia and Far East | 879,700 | 10,998,940 |
| Latin America | 1,040,000 | |
| *Total* | 17,048,109 | 19,915,440 |

# Socio-economic aspects of fisheries development

**Rowena M. Lawson**
University of Hull, UK

## Summary

Problems facing the development of small-scale fisheries can be broadly divided into two categories; those internal to the small-scale sector and those concerning its relationship with large-scale fisheries. Fundamental improvements are dependent upon a comprehensive input package which may cover marketing, credit facilities, improved infrastructure, extension and training. Alternative strategies may involve co-operatives, associations or fish marketing boards.

The provision of these inputs often involves government subsidies or direct state control. However, the costs and benefits of the small- and large-scale sectors of the industry are quite different; unless this is realized, a misallocation of resources is inevitable. Whilst large-scale fisheries may be justified on financial criteria only, small-scale fisheries must be evaluated using a wider cost-benefit analysis. The cost of supporting a small-scale fishery may be far outweighed by the social cost incurred by failing to provide the necessary support.

Without assistance, may small-scale fisheries are bound to decline in the face of competition from large-scale operations mainly because the marketing costs are so much higher. The paper reviews the experience of some developing countries and suggests appropriate government strategies to prevent this decline.

## Résumé

Les problèmes concernant le développement des petites entreprises de pêche peuvent dans l'ensemble être divisés en deux groups, ceux concernant la petite pêche en ell-même et ceux concernant ses relations avec les grandes entreprises de pêche. Des améliorations essentielles sont fonction d'un ensemble de conditions comprenant la commercialisation, les facilités de crédit, l'amélioration de l'infrastructure, l'extension et la formation. D'autres dispositions peuvent concerner des coopératives, des associations ou des groupements de marchés.

La réalisation de tels projets suppose souvent des subventions gouvernementales et un contrôle direct de l'Etat. Cependant, les coûts et bénéfices des petites et des grandes entreprises de ce secteur industriel sont tout à fait différents. A moins que ce qui vient d'être dit soit pris en considération, une disparité de ressources est inévitable. Tandis qu'une grande entreprise de pêche peut se justifier sur les seuls criterès financiers, les petites entreprises de pêche doivent être appréciées en tenant compte d'une analyse coût-bénéfice plus complète. Le coût de l'aide à une entreprise de petite dimension doit être jugé en tenant compte de ce qu'il en coûterait en frais sociaux si on omettait de fournir l'aide nécessaire.

Sans subventions, beaucoup de petites entreprises de pêche sont destinées à décliner dans la compétition avec des organismes plus importants à cause des prix de commercialisation qui sont beaucoup plus élevés. L'article passe en revue l'expérience de quelques pays en voie de développement et suggère des mesures gouvernementales appropriées pour empêcher ce déclin.

## Resumen

Los problemas que plantea el desarrollo de las pequeñas pesquerías a pequeña escala pueden dividirse en dos grandes categorías, las propias de las industrias a pequeña escala y los referentes a sus relaciones con las pesquerías a gran escala. Las mejoras fundamentales dependen de un amplio conjunto de medidas relativas a la comercialización, facilidades de crédito, infraestructura, extensión y formación de personal. Otras estrategias alternativas a desarrollar son la formación de cooperativas, asociaciones o grupos de comercialización.

La provisión de tales medidas incluye, a menudo, subsidios gubernamentales o control directo estatal. Sin embargo, los costos y beneficios de las industrias a pequeña y gran escala son totalmente diferentes. A menos de tener en cuenta ésto, es inevitable una mala alocación de los recursos. Mientras que las pesquerías a gran escala pueden justificarse utilizando sólamente criterios financieros, las pesquerías a pequeña escala deben evaluarse utilizando una análisis más amplio de costo-beneficios. El costo de soporte de una pesquería a pequeña escala puede estar muy compensado por el costo social que supondría la falta de proveer el necesario soporte.

Sin asistencia, muchas pesquerías a pequeña escala estarían condenada a desaparecer a causa de la competencia de las operaciones a gran escala, principalmente porque los costes de comercialización son mucho más altos. El informe presenta una revisión de las experiencias de algunos países de vías de desarrollo y sugiere las estrategias gubernamentales convenientes para evitar el declinar de dichas pesquerías.

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## Introduction

The socio-economic problems facing the development of small-scale fisheries can broadly be divided into two categories; those internal to the small-scale sector and those concerning its relationship with large-scale fisheries, which can be considered at a macro-economic level. Aspects relating to the second category involve the consideration of the socio-economic effects of the attraction of the larger scale, more profitable fisheries and the effect this has on small-scale fisheries.

The justification for expanding and strengthening small-scale fisheries lies not so much in the economic returns to be obtained but in the social benefits; these accrue to the stability of rural populations and the securing of some level of employment and income in contrast to the alternatives of unemployment and poverty in urban areas. However, in addition to the attraction of the urban pull, small-scale fishermen are frequently enticed to move to large fishing ports from which a large-scale fishery operates; this is because the earnings on larger vessels generally offer a basic stability of earnings over a longer period of the year and often a higher level of annual income.

In the long run, the small-scale fishermen, especially those who live in small scattered villages along a remote coastline, may have little chance of survival against the competition of large-scale fishing enterprises. This is because, although the marginal cost of small-scale fishing (which is a labour-intensive industry) is lower than large-scale fishing (which is capital-intensive), the cost of marketing is much higher for the small-scale fishing due to the collecting costs, risks and rate of spoilage being much higher for the trader. For this reason, small-scale fisheries will gradually diminish to a level which provides fish only for markets within a low-cost marketing range of the landing point unless some government assistance and support is given.

It must be realized that, whilst there is a national money cost which must be borne when sustaining small-scale fisheries, there are social returns (such as the greater employment and stability which is brought to the rural fishing communities) which may not be easily measured in monetary terms. In countries which are experiencing both rapid population growth and increasing rural-urban drift, these returns may represent very important social benefits. This aspect of fisheries planning has been discussed elsewhere and will not be dealt with in this paper (Lawson, 1974).

## The socio-economic framework

Many of the major socio-economic problems which are internal to the small-scale fishing sector have been widely discussed, notably at international and regional conferences and symposia organized by the Fisheries Department of FAO, and will only be summarized here (FAO, 1975). A survey of the literature, however, reveals that, as a result of greater research and experience in the field, considerable modification is now being made to earlier concepts about the socio-economic framework of the traditional small-scale fisheries in developing countries. This paper will attempt to question some of the concepts which have been popularly held (Lawson, 1972).

Experience has been gained by many countries in their attempts to upgrade the small-scale fishery by the application of inputs designed to improve the level of production and raise the fishermen's incomes (Lawson and Kwei, 1974). The obvious way of doing this was first considered to be by the introduction of new improved gear and equipment but it was soon found that this was no easy task and required administration by a suitable training and extension service. To enable fishermen to own their own gear and vessels, many governments were obliged to devise some scheme for providing the fishermen with adequate credit and loan capital. Some of the countries which pioneered loans schemes, however, soon found that their ability to obtain debt repayments were frustrated by what they considered to be the control exercised in the industry by traditional fish traders; many of these fish traders also provided capital to the industry and, therefore, simultaneously performed a trading-financing function. As a result of this, the inputs applied to develop the small-scale sector were enlarged to include the introduction of supposed improvements to the marketing network, which aimed at reducing the power of the traditional trader and giving the fishermen a greater share of the catch. It was assumed that, given such an opportunity, fishermen would work harder to increase their levels of income and, hopefully, use some of it to invest in their own vessels.

Field research tends to indicate that much of this attack on trader-financiers is based on a misunderstanding of the wide array of functions which they perform and an exaggeration of their power. It is true that under certain conditions monopoly, monopsony or oligopoly do exist but these do not necessarily exploit the fishermen, who also do not always resent them; generally, fishermen and trader-financiers have a mutually beneficial relationship, which operates smoothly in a traditional environment. Any interference in this environment is bound to be resented by all parties. An example of this is provided by Ghana's experience when it first attempted to introduce mechanized vessels in the mid 1950's; this was effectively resisted by both canoe fishermen and traders who combined forces on the beach to prevent fish being landed from mechanized vessels (Lawson, 1967).

In many countries, attempts to introduce wholesale markets or an auction market for fish trade have frequently met with boycotts as is now occurring in Malaysia (Lawson, 1975). Unless there are obvious benefits to the fish trader as well as to the fishermen, it is likely that the traditional fish marketing system will continue due to the threat of action which could come from both fishermen and traders. In many developing countries, there are large government built wholesale markets which are little used; an understanding of the socio-economic functions of traders in the traditional fishing sector would have indicated beforehand that this would be a likely result.

For example, the basic assumption, which has underlaid government intervention in marketing by the provision of improved marketing and credit facilities, has been that small-scale fishermen are tied up in a spiralling debt situation with the traditional trader-financiers who perform the essential credit and marketing functions. Unfortunately, the trader and middlemen in all communities tend to be the focus of political attack, especially in countries where the trading function is undertaken by racial minorities as, for example, in many SE Asian countries. In all countries, he is seen as adding nothing to the real value of the product, he is considered to be a parasite and the real value of his trading functions (as a 'risk-taker', collector, assembler, organizer and redistributor) frequently pass unvalued.

The roles of the trader-financier as both a financier and a market functionary must be seen as complementary commercial activities. Whereas, in many places in SE Asia and in India, the trader-financier owns the vessels and gear which are used by the fishermen, it should not be assumed (without an examination of the socio-economic functions performed under this traditional system of ownership) that the trader-financier is exploiting the fishermen or even that the traditional small-scale fishermen really want to become vessel owners themselves.

In Malaysia, usually the trader who is also a vessel owner is effectively hiring his vessel out to fishermen in return for being able to secure supplies of fish. Studies indicate that when this occurs, taken by itself, the trader's vessel and gear owning operation is probably provided below cost and is supported by the income he earns from the fish trade. If a government operates on the assumption that, by giving loans to fishermen to enable them to purchase their own vessels, they are in fact helping the fishermen, in reality this may be far from the case. If, under a government's loan scheme, the full cost of lending is passed on to the fisherman, he will effectively be forced to pay a higher price for the use of the vessel than he has hitherto been paying to the trader (towkay) under trader ownership. In fact, the person most likely to benefit from a scheme to increase vessel ownership amongst fishermen would be the trader himself since the main purpose of his owning vessels is to secure a supply of fish for his own trading purposes. A government loans scheme which gives vessel ownership to fishermen would save the trader both capital and 'risk-taking'.

A prerequisite to involving small-scale fishermen in becoming vessel owners should be an examination of the current system of gear and vessel ownership and the socio-economic implications of this system. In Malaysia, it is often said that boat owners, who customarily get a 50% share of the catch, exploit the fishermen and, if the fishermen owned vessels themselves, their income would be greatly increased. However, few small-scale fishermen do own their own vessels and there are probably good reasons for this. These should be explored before the system is disrupted.

Case studies of the commercial activities of small-scale fisheries have shown that the boat owning function of the enterprise earns a return of 10 to 15% only. This is probably well below the opportunity cost of capital in all developing countries, which is usually at least 20 to 25% at free market prices. Even the most enterprising fishermen may not find the low rate of return of 10% on vessel ownership attractive enough to induce him to invest. If the rate of return on vessel ownership is low, this explains why the vessel owner needs to combine it with some other, more profitable, involvement in the industry (eg in the marketing of fish); with this he would hope to earn a large enough profit so that his combined activities of financier and fish trader make a reasonable aggregate rate of return on his capital plus a reward for his time, effort, enterprise and risk.

Before imposing artisanal fishermen with the capital risk of vessel ownership, it should be realized that it is not easy to turn people, who, for decades, have been dependent on the work created by the 'risk-taking' of others, into entrepreneurs. Furthermore, it is not established that all small-scale fishermen wish to be entrepreneurs on their own account. The complete change of attitude which is needed does not come quickly or easily and, if small-scale fishermen are persuaded to make changes too quickly at a pace too rapid for them to assimilate, the changes are unlikely to be successful. As with all low-income rural producers, it is likely that the artisanal fisherman's greatest need is primarily for a guaranteed minimum subsistence level of income. This is a prominent, fundamental and very common human motivation in both artisanal fisheries and traditional small-scale farming throughout the world. It could be considered that the price paid by the fishermen for a confident level of subsistence is his willingness to enter into a perpetual debt relationship with the trader-financier. If this is the case, he is unlikely to forgo this security for the possible hazards of extreme poverty or success.

It is frequently stated that fishermen are not free to determine for themselves the marketing outlets which they can use because no alternatives are offered since they are tied to a towkay or trader-financier. In some SE Asian countries, discussion of this tends to be overshadowed by political and emotive overtones and it is, therefore, most important that impartial objective studies should be made of the factual relationship.

Studies in other countries have shown that, in the traditional peasant and fishing sector, much money is raised from friends and relatives often for either a very low interest rate or no charge.

Out of season, most fishermen are forced to borrow money for food; therefore, the incidence of debt is seasonal and much of the credit may be given by shopkeepers and general traders who are not connected with the fishing industry. The need for short-term finance, which is small in amount and frequently needs to be given quickly, is characteristic of all societies where production is small-scale, seasonal and where no alternative source of income is available. Since most borrowing is undertaken within the traditional sector itself and is based on mutual trust and respect between members of the community, there are few bad debts, debt collection is cheap and those responsible for giving credit or making loans generally know exactly how much they can safely give. To replace this system with institutional lending would be costly, risky, cumbersome and probably also 'bogged down' by bureaucracy.

The fish traders' motivations for lending are not for the extortion of a high rate of interest but mainly for the specific purpose of securing regular supplies of fish and for ensuring a continued business relationship. Very few traditional small-scale fishermen, in fact, complain about this since they realize the value of the system to them. Their landings are generally too small to give employment to more than a few traders and the fishermen themselves are too exhausted, once they reach the shore, to search for fish buyers. In fact, the few studies which have been made show that the proportion of the final price of fish paid to the fisherman (generally in the region of 30%) is not very different from the return to the primary producer (and may be much higher in certain cases) in many fisheries, and also in farming, all over the world.

The granting of loan facilities is not a one-way activity. In a recent study in Malaysia, it has been shown that movement of loan funds extends from fishermen to traders and that this forms an important part of the short-period funding of coastal traders, who are forced to sell on credit to inland wholesalers (Lin Chong Keat, 1976). Of the 270 fishermen studied, approximately 20% extended credit to traders.

## The organization of inputs

Alternative strategies for applying the input package, eg through co-operatives (many countries), Fishermen's Associations (Malaysia, Thailand and Taiwan) and Fish Marketing Organizations (Hong Kong), have been widely discussed in the literature, much of which is available in papers and reports produced by FAO. Of these, the Hong Kong Fish Marketing Organization (FMO) has perhaps been the most successful. In this scheme, fishermen who have obtained government loans to purchase improved gear and vessels are expected to repay their debts by transferring approximately 15% of the value of their landings to the FMO and a high repayment rate has resulted. It is not suggested, however, that the Hong Kong model, successful as it has been, could be universally applied without a great deal of modification to local conditions. The geography of Hong Kong, which is a very small island with relatively few fishing ports, facilitates fairly close control and supervision of the fishery. In most other countries, few loans schemes have succeeded in making much of an impact in improving incomes for small-scale fishermen; in some instances, the larger scale fishermen or boat owners and even the trader-financiers have benefited most. The reasons for failure have been numerous, ranging from inadequacies in methods of control and administration to difficulties in establishing a system of lending priorities which is both equitable and commercially viable, and in securing the repayment of debts. Frequently, however, improvement schemes have been too ambitious.

All strategies which have attempted to introduce improvements have been based on the assumption that the existing traditional institutions which encompass the small-scale fishing sector are either inefficient, inappropriate, inadequate or inequitable (or a combination of these) as a means of promoting growth. In fact, the failure of government schemes to improve conditions lies largely on the neglect to examine and understand the fundamental socio-economic organization of the traditional industry. For example, one of the earlier arguments in favour of introducing outboard motors to the canoe fishery was that they would be labour saving. In Ghana, when outboard motors were first introduced, instead of the usual seven men per canoe, there were sometimes as many as eleven or thirteen men. The advisers had failed to realize the socio-economic involvement of the extended family in fishing activities and the fact that, at that time, large numbers of able-bodied men had no other alternative economic activity.

What is needed in most less developed countries today is not labour-saving but labour-using techniques. Planners are at least adopting a more realistic evaluation of factor prices so it is realized that scarce capital resources are costly and the plentiful supplies of labour have a low opportunity cost. If a more realistic system of factor pricing were adopted, capital for large fishing vessels would bear its true high market cost, there would be no more cheap highly subsidized loans schemes to help large-scale fishermen and the smaller scale labour-intensive fishery would be evaluated more favourably.

In addition, field studies of the organization of traditional small-scale fisheries which embrace socio-economic considerations would probably reveal a greatly underrated factor of production in the organization and institutional arrangements within which the small-scale fishery operates. The economic value of this organization has never been evaluated but experience has shown that where governments (or fisheries departments) have tried to replace it with bureaucratic organization, the costs have been high and the schemes rendered ineffective. This has generally occurred because they were introduced and imposed by people who had little understanding of the real value, in social and economic terms, of traditional fisheries.

## References

**FAO** (1975) *Report of The Expert Consultation on Small-Scale Fisheries Development.* Rome.

**Lawson, R. M.** (1967) The growth of the fishing industry in Ghana, *Econ. Bull. Ghana,* XI, 3.

**Lawson, R. M.** (1972) *Report on credit for artisanal fisheries in SE Asia.* Rome: FAO.

**Lawson, R. M.** (1974) Fisheries development and planning in the Indo-Pacific Region – its objectives and constraints. Rome: FAO, Indo-Pacific Fisheries Council.

**Lawson, R. M.** (1975) *Interim report on socio-economic aspects of the development of artisanal fisheries on the East Coast of Malaysia.* UNDP/South China Sea Programme.

**Lawson, R. M. and Kwei, E.** (1974) *African entrepreneurship and economic growth. A case study of the Fishing Industry of Ghana.* Ghana Universities Press.

**Lim Chong Keat** (1976) A diagnostic study of the marine fish middlemen marketing system in the East Coast of Peninsular Malaysia. Thesis produced for Master of Economics, University of Malaya.

# The economics of fish processing

**J. R. Shaw**
Tropical Products Institute, UK

### Summary

This paper is concerned principally with three forms of fish processing, namely canning, freezing and fishmeal production. Details of the levels of capital and operating expenditure associated with each type of process, at varying levels of throughput, are provided. Interpretation of these data leads to comments on the cost structure of the processes and the implications they may have for those considering fish processing industries in tropical countries.

### Résumé

Cet article traite essentiellement de trois méthodes de préparation du poisson, c'est-à-dire la mise en conserve, la congélation et la production de farine de poisson. Les détails concernant les niveaux de dépense capitale et les frais de fonctionnement pour chaque type d'opération à divers niveaux de rendement sont fournis. L'interprétation de ces données conduit à des commentaires sur le coût de ces opérations et sur les implications possibles qu'elles peuvent avoir pour les industries de préparation du poisson dans les pays tropicaux.

### Resumen

Este informe trata, principalmente, de tres formas de elaboración de pescados, conservas en lata, congelación y producción de harina de pescado. Suministra diversos detalles de los niveles de capital y gastos de operación asociados con cada tipo de procesamiento a distintos niveles de producción. La interpretación de estos datos conduce a comentarios sobre la estructura de costos de los procesos y las posibles implicaciones que pueden existir para los interesados en las industrias de elaboración de pescados en los países tropicales.

### Introduction

This paper is intended to provide indicative economic parameters, prior to carrying out full-scale feasibility studies, for those contemplating investment in the fish processing industries, primarily in the developing countries. The three principal forms of processing considered are fish canning, fish freezing and fishmeal production. For the purposes of this paper, these methods of processing are looked upon as independent processes but it is readily conceded that an amalgam of two of the processes on one site is not unusual and it is becoming more common for all three to be sited together, even in developing countries. It requires an extension of this analysis to determine the economic implications of a more integrated approach to fish processing.

The parameters are based largely upon the cost of plant and equipment bought in a developed country and then freighted to, and operated in, a developing country. Inevitably, the figures represent only an order of magnitude and should only be used as such. Precise costings of individual case studies remain the sphere of the feasibility study. However, it is possible to provide guidelines for potential investors not only for the absolute amounts of finance involved but also regarding the relative importance of individual components both within and between processes. It is not possible to spell out fully every assumption but, as fast as possible, the information presented is based upon estimates available during the past six months.

The analysis is presented along traditional lines which mirror the actual financial flows of the investment. In other words, the capital investment is amortized to simulate equal annual repayments to the bank and, when added to other unavoidable annual payments, such as rent, give the total fixed costs of the operation. The addition of operating costs completes the cost side of the equation. The whole, deducted from the expected revenue, represents a measure of the enterprise's profitability.

Capital costs include buildings, plant and equipment design and installation charges, taxes, fees, freight, insurance and contingency elements.

*Building costs*

These tend to be a major item, especially if difficulties are encountered in obtaining essential supplies such as steel and cement. Building costs vary widely according to materials and specifications but as a general guideline costs of US \$100–150 per m$^2$ are currently about average. Particularly difficult conditions could warrant a higher figure.

The size of building needed obviously increases with the capacity of the plant but this is not necessarily a linear function since often the actual plant takes up a relatively small proportion of the total area. The remainder would be taken up by storage space (for both raw materials and end-products), ancillary activities, such as preparation and packaging, and office space. The size of building has to accommodate these functions irrespective of the actual size of the plant. In terms of building area, a small-to-medium-size plant and ancillary activities may occupy only 200–300m$^2$ but the whole operation is unlikely to be able to function in much less than 500–800m$^2$; the additional space is required mainly for storage. Fishmeal plants tend to be the most economical in their requirements. The lower figure of the range quoted should amply accommodate a medium-sized reduction plant. On the other hand, 800m$^2$ is approaching the bare minimum for a small cannery. Furthermore, whilst increased plant capacity in the case of a reduction plant has a relatively slight effect upon overall space requirements, a medium sized cannery operation (handling 20–30 tons of raw fish a day) is unlikely to be accommodated efficiently in much less than 2000m$^2$.

On this basis, total building costs including office and storage facilities are unlikely to amount to less than US \$50,000 and may well reach US \$90,000 for even the minimum size of plant. Increasing the capacity of a fishmeal plant has a relatively slight effect on total building costs. For example, a fishmeal plant with a through-put of 100 tons of raw material in an 8 hour day could be accommodated within a total building cost of around US \$100,000. Canning and freezing facilities tend to be somewhat more demanding and similar through-puts could cost more than twice as much. Table 1 indicates the general level of building costs in relation to through-put, their annual cost on the basis of a 20 year life span at 12% interest and, consequently, the order of magnitude per ton of raw material processed.

TABLE 1. *Building cost per ton of raw material*

| *Capacity (tons of raw material per day)* | *Total building costs (US \$ × 10³)* | *Annual equivalent (US \$ × 10³)* | *Cost per ton of capacity* (US \$)* |
|---|---|---|---|
| 1– 5 | 30– 60 | 4– 8 | 18–7 |
| 6– 20 | 40– 90 | 5–12 | 4–3 |
| 21– 50 | 65–190 | 9–25 | 2–2 |
| 51–100 | 100–240 | 13–32 | 1–1 |

* No. of working days = 225.

It is readily apparent that the small plant, housed in a building of generally accepted standards, is at a considerable disadvantage in relation to larger plant capacities if it has to bear the full cost of buildings. It is, therefore, a considerable advantage if developing countries can obtain concessionary terms for such investment, particularly when it is remembered that the market open to a young industry often needs developing and therefore a relatively small initial plant capacity is more appropriate.

*Plant and ancillary equipment costs*

The plant and ancillary equipment is generally the most expensive single item of expenditure. Precise costs depend very much upon plant size and degree of automation but the underlying assumption made here is that operations remain labour intensive as far as possible.

Fishmeal manufacturing involves a number of individual units in addition to the basic fishmeal plant, including a separator, evaporator, deodorizer and boiler unit. The smallest fishmeal line processing about 2 tons of raw material per 8 hour* shift now costs in the region of US \$100,000, rising to around US \$400,000 for a plant processing 20 tons per 8 hour shift, to in excess of US \$1,000,000 for a plant handling 200 tons in the same period.

A canning plant consists essentially of dressing, washing, cooking, dispensing, retorting and packaging operations. Of these, cooking, retorting and packaging tend to be the most capital intensive. The minimum plant investment is likely to be about US \$170,000 for a plant with a through-put of about 2 tons of raw material per day, rising to US \$300,000 for a plant handling 10 tons of raw material a day and to US \$500,000 for a 30 tons per day plant, which is still a comparatively small enterprise.

It is difficult to be precise when discussing freezing plant through-puts since so much depends upon the actual product involved and the amount of 'processing' it undergoes. Through-puts are generally related to the capacity of the freezing unit which may vary from one-fifth of a ton to 50 tons per day. The cost of freezing units is relatively small but the actual freezer represents only a small proportion of the probable plant cost. The smallest freezing unit costs about US \$10,000 and the largest about US \$250,000. However, the addition of ancillary equipment and storage facilities for a plant freezing 1–2 tons of raw material per day would probably put the minimum plant and equipment cost in the region of US \$40,000, rising to US \$100,000 for a freezing plant handling 5–8 tons of raw material a day. It must also be remembered that a freezing plant should preferably be associated with a network of similar facilities at the wholesale and retail levels and to some degree also at the consumer level. This investment cost is not included here but would be essential for the most efficient utilization of a freezing enterprise.

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*Normal practice would be to maintain a fishmeal process throughout 24 hours if possible. However, for comparative purposes the time period used has been taken as one 8 hour shift. This does not affect the result of the analysis.

TABLE 2. *Plant and equipment costs per ton of raw material*

| *Capacity (tons of raw material per day)* | *Total plant cost (US $ x 10³)* | *Annual equivalent (US $ x 10³)* | *Annual throughput in 225 days (tons)* | *Cost per ton of raw materials (US $)* |
|---|---|---|---|---|
| 1– 5 | 60–170 | 11– 30 | 225– 1,125 | 49–27 |
| 6– 20 | 160–400 | 28– 71 | 1,350– 4,500 | 21–16 |
| 21– 50 | 230–500 | 41–103 | 4,725–11,250 | 9– 9 |
| 51–100 | 370–780 | 65–138 | 11,475–22,500 | 6– 6 |

Table 2 outlines a similar calculation to that done for building costs. Plant and equipment costs for varying through-puts of raw material are given and reduced to an annual rate of repayment assuming a 10 year life span and a 12% interest rate.

### *Additional costs*

As well as building and plant costs ex-works, allowance has to be made for additional costs incurred to the point of commissioning of the plant. The most obvious items are the erection and installation costs, freight and insurance, and any taxes or duties payable. A contingency item is also usually included. As a rule of thumb, installation charges, incorporating connection of services, pre-production trials, spare parts allowance and supervision fees, may be calculated at 10–12% of the capital cost.

Freight and insurance charges can vary widely depending on volume, weight and destination of the goods transported but, for illustrative purposes, a conservative figure of 20% of the value of the goods may be used. Taxes and duties vary enormously and can be quite severe on certain items of equipment. Concessions are sometimes available for items provided within official aid programmes. A contingency sum of 10% of the estimated capital requirement is normally included in any provision budget.

### *Total capital costs*

Table 3 summarizes the capital costs involved on an annual equivalent basis in establishing fish processing facilities. The relationship of capital costs to plant through-put is self-evident. It is an important relationship and there are obvious attractions to entrepreneurs in opting for a medium-size plant with a through-put of say 25–30 tons of raw material per day.

TABLE 3. *Indicative capital costs of fish processing plants (annual equivalent basis)*

| *Capacity (tons of raw material per day)* | *Building costs (US $ x 10³)* | *Plant costs (US $ x 10³)* | *Miscellaneous* (US $ x 10³)* | *Total costs (US $ x 10³)* | *Cost per ton of raw material (US $)* | *Cost per ton of raw material at ²/₃ capacity (US $)* |
|---|---|---|---|---|---|---|
| 1– 5 | 4– 8 | 11– 30 | 6–14 | 21–52 | 93–45 | 140–69 |
| 6– 20 | 5–12 | 28– 71 | 12–30 | 45–113 | 33–25 | 50–38 |
| 21– 50 | 9–25 | 41–103 | 18–47 | 68–175 | 14–16 | 21–24 |
| 51–100 | 13–32 | 65–138 | 29–62 | 107–232 | 9–10 | 14–15 |

*Calculated at 10% site costs, 10% contingency allowance and 20% for freight insurance, but excluding allowance for taxes and duties.

The other side of the equation, namely demand for the product, needs to be considered very carefully. The result of over-estimating demand and perhaps having to run a plant at only two-thirds capacity is illustrated by Table 3. For example, a plant with a capacity of 20 tons per day running at two-thirds capacity has higher overheads than a 6 tons per day plant running at full capacity. Similarly 51–100 tons per day plants running at two-thirds capacity have much the same overhead costs as a 21–50 ton per day plant at full capacity.

### **Annual fixed costs**

In addition to the annuity value of the initial capital investment, several other items of a fixed nature (ie they do not vary with the level of operation and have to be paid whether the plant is working or not) must be included. The most important are rent, maintenance costs, insurance, taxes and management expenses. For the purpose of establishing guidelines, insurance and maintenance costs can again be based upon a percentage of the plant's value, 2% for the former and 5% for the latter. The rental value used is most likely to be the annual cost of a lease on the land. In broad terms, a figure of US $10 per m² should prove an adequate allowance in most parts of the developing world. Company tax laws vary so much that any allowance should be made on the basis of first hand knowledge of each situation but, for the purposes of this exercise, a figure of 10% of gross profit should again prove adequate. Often, new enterprises are given a tax holiday of up to five years, particularly small industries, but it is prudent to check on such potential allowances at an early date in the planning process. Conventionally, management costs are considered as annual fixed costs although this often gives rise to questions of definition; an inactive plant would not necessarily incur a management cost. Normally, even the smallest plant should budget for management costs of about US $20,000 per annum; for larger plants the allowance should be nearer US $50,000. Finally, the enterprise is likely to need working capital of the order of three months' production costs upon which interest will also be paid. The sum total of these costs in relation to daily processing capacity is shown in Table 4.

TABLE 4. *Annual fixed costs of fish processing plant*

| *Capacity (tons of raw material)* | *Total annual fixed costs (US $ x $10^3$)* | *Processing capacity (tons of raw material)* | *Cost per ton (US $)* |
|---|---|---|---|
| 1– 5 | 33– 40 | 225– 1,125 | 147–36 |
| 6– 20 | 40– 70 | 1,350– 4,500 | 30–16 |
| 21– 50 | 64–105 | 4,725–11,250 | 14– 9 |
| 51–100 | 99–140 | 11,475–22,500 | 9– 6 |

Taken together, the annual fixed costs plus the annual repayment charges (Table 3) can amount (in the case of small plants) to a cost per ton of raw material of the order of US $250. However, the larger capacity plants reduce this figure to less than US $20 per ton of material processed.

The range of estimates in Table 4 is inevitably subject to a wide margin of error, particularly those associated with the smallest capacity range. Nevertheless, the enormous potential burden that small capacity plants have to bear is readily apparent. Again, a medium-size plant of 20–30 tons capacity per day looks the more attractive instalment.

**Operating costs**

The principal variable costs are of the raw material, labour, utilities (fuel, electricity and water) and packaging.

*Raw material*

The cost of raw material is crucial to any of the processes mentioned, principally because it is usually the primary cost element per unit of capacity and also the one subject to the greatest fluctuations. As shown in Table 3, even the capital investment in a process, reduced to annual payments, is often of relatively little consequence when formulating an annual budget. Fishmeal manufacturing can obviously make use of raw material such as fish offal that would not be canned or frozen. The majority of fishmeal manufacturers would hope to be able to obtain raw material for US $40–50 per ton. The price of fish for canning or freezing depends largely on species and seasonality but ranges from US $160–380 per ton, shellfish being the most expensive. The important factor is not so much the absolute price level of the raw material but the influence it has on the price of the final product, bearing in mind processing costs and the conversion losses in making the end-product.

*Utilities*

All processing plants need a power supply and utilities in one form or another. Fish processing plants obtain power usually through high voltage current from a mains supply, possibly in conjunction with their own substation. In some parts of the world, current fluctuations and even power cuts can cause problems meriting the installation of a stand-by generator. Electricity costs are likely to be in the region of US $0.10–0.15 per kWh and power consumption in the range of 20–40 kWh per ton of raw material processed depending upon the size of plant. Small plants tend to have a higher requirement per ton of raw material processed.

Fuel oil is generally used in boilers, particularly for the generation of steam required in the reduction and canning processes. Most of the fuel oil requirement in fishmeal production is associated with the evaporation plant in the absence of which the fuel oil requirement could possibly be halved. On the other hand, a small freezing plant may well rely entirely upon a mains electricity supply. A budget figure of the order of 30–70 kg of fuel per ton of raw material would encompass the needs of most small- to medium-size plants. Fuel oil is generally available at around US $0.12 per kg.

Water, apart from being an integral part of any freezing plant process, is needed for boilers, cleaning, cooling and staff facilities. Enterprises may have a mains supply available but could be faced with all or part of the cost of installing their own supply from a bore-hole. Freezing plants are especially demanding of a clean, ample water supply. Even a relatively small plant processing 2 tons of raw material a day will use upwards of 3 million gallons annually or about 290 m$^3$ per ton of raw material. Canning and reduction processes use less although a small cannery is likely to need about 150 m$^3$ per ton of raw material. A reduction plant uses water mostly for cooling and deodorizing and could function adequately using 40 m$^3$ per ton of raw material.

*Labour*

Another very important operational cost is that of labour, which is often divided on the basis of administrative/clerical staff and production staff. In small enterprises, costs can be saved if the production and sales manager are the same person but in large plants, production and marketing will be separate functions. Again, the small plant will probably need some clerical assistance but most of the book-keeping would fall upon the entrepreneur himself. A further facility that small plants also tend to forgo is to have their raw materials and end-products regularly monitored by laboratory analysis. This is an essential requirement for larger plants but could be contracted out by the smaller enterprise. The number of manufacturing personnel needed is essentially a function of volume, layout and degree of automation.

A fishmeal plant is relatively capital intensive, most labour being needed for unloading (assuming it is done by plant staff), operating the processing line and bagging off. However, a plant processing up to 20 tons of fish per shift would probably employ only 4–5 staff and plants processing 200 tons per shift are likely to make do with perhaps 15 employees. These numbers are in sharp contrast to the production workers required by a labour-intensive cannery. Operations such as unloading, beheading, gutting, filling of cans, loading cans into cookers and retorts and the packaging of cans are all amenable to hand labour. A cannery processing 2 tons of raw material per day could utilize up to 90 production workers of whom 40 could be dispensed with if beheading and gutting were carried out by machine. Larger canneries (processing 20–30 tons of raw material a day) may employ perhaps 300 production workers in addition to 15–20 supervisory and administrative staff.

In terms of labour requirements, freezing plants tend to occupy an intermediate position between reduction and canning but, again, much depends upon the degree of preparation needed by the frozen product. The tendency in many developing countries is to carry out far less beheading and gutting of fish than would be deemed desirable in Western Europe. A small freezing plant processing around 2 tons of raw material per day would employ perhaps 20–25 staff in all, most of whom would again be involved in the reception, preparation and packaging operations. Plants processing 20 tons of raw material in a day could employ 80–100 production workers plus supervisory and administrative staff.

Labour costs of industrial workers (unskilled to semi-skilled) in the developing countries tend to range from US $3–4 per day.

### *Packaging*

The final significant operating cost is that attached to packaging materials. Fish meal is normally bagged; an allowance of 22 bags per ton of meal at a cost of US $0.60 each should prove adequate. The cost of cans has increased rapidly in a relatively short period of time; a standard 15 oz can now costs US $80 per 1000. A cannery processing tuna, for example, will need approximately 1200 of these cans per ton of raw material processed. Individual cans are also labelled and packed in cases at US $0.27 per case. Other forms of packaging include plastic bags costing US $15 per 1000 (for which a sealing machine would be necessary) and cartons (8 oz) at US $22 per 1000.

### *Total operating costs*

In total, the operational costs can therefore occupy a wide range but a clear distinction can be drawn between fishmeal production and the other processes. The total operating costs of a fishmeal plant are likely to vary from US $50–70 per ton of raw material, the principal variable cost being the raw material. In the case of large reduction plants, the raw material cost is likely to be the major cost factor in the whole enterprise but smaller scale plants may also have to contend with relatively high fixed costs per ton of capacity.

The more labour-intensive operations such as canning and freezing have considerably higher operating costs. In addition to labour costs the other major items tend to be raw material and packaging costs. Together, these three factors account for 95% of operating costs. There will inevitably be a broader range of operating costs associated with these processes than with fishmeal production but again, as an order of magnitude, a range of US $480–780 should encompass most sizes and types of operation.

## Conclusions

The total picture depends upon the proportional relationship between operating costs and the annual costs of the capital investment. Taken together, the total costs give rise to some doubt as to the economic viability of the smallest plants on the basis of the assumptions in this paper. For example, a small fishmeal plant may well incur annual fixed costs equivalent to its operating costs, a situation which would make its total costs of the order of US $100 per ton of raw material. Given a 25% product yield, this implies a total cost per ton of meal of the order of US $400. This is considerably above the lowest cost operations which would be hoping for costs per ton of meal in the range of US $200–220. The difference is largely due to the impact of the fixed costs being spread over a small through-put.

The relationship between fixed and operating costs is slightly different in the case of the freezing and canning operations. Even at the smallest scale, the annual fixed costs do not reach a similar level of importance in relation to the total costs of the operation. Consequently, one is able to think in terms of smaller throughputs without the initial calculation becoming overloaded with capital repayment costs in the way that fishmeal plant costs tend to become; the higher absolute levels of labour, raw material and packaging costs ensure that the fixed cost element remains a relatively minor one even in the case of small-scale plants.

However, it is difficult to avoid the conclusion that the smallest scale of plant is at a disadvantage if one associates such enterprises with a similar qualitative capital input to that for large-scale plants. It is understandably of benefit if a compromise is possible, in terms of building and plant costs, which will still ensure adequate and efficient operations without necessarily incorporating some of the features which are seen as an integral part of larger installations.

Similarly it is apparent that plants with a through-put of 20–30 tons of raw material per day have a certain attraction in that beyond this scale the benefits of economics in scale are not nearly as dramatic as they are up to this level. However, the points made earlier concerning the relationship between capacity and demand should be borne in mind.

# Developments in fish utilization

**D. G. James and W. Krone**
Department of Fisheries, FAO, Rome

### Summary

Changing trends in the pattern of fish utilization are discussed against the background of present production and the prospects of increased catches. The growth of processing and distribution capacity in developing countries by intensification of traditional methods is compared with the possible advantages of introducing complex industrial technology. The financial and technological requirements for development are outlined.

### Résumé

Des modifications dans les modes d'utilisation du poisson sont discutés par rapport à la production actuelle et aux perspectives de l'augmentation de la pêche. La croissance des possibilités de préparation et de distribution dans les pays en voie de développement par l'intensification des méthodes traditionnelles est comparée avec les avantages éventuels de l'introduction d'une technologie industrielle complexe. Les besoins financiers et technologiques pour le développement sont esquissés.

### Resumen

Se discuten las tendencias cambiantes en los sistemas de utilización del pescado frente a las bases de la producción presente y las perspectivas de incremento de la pesca. El crecimiento de la capacidad de elaboración y distribución, en los países en vias de desarrollo, mediante la intensificación de los métodos tradicionales se compara con las ventajas posibles de introducción de la compleja tecnología industrial. Se subrayan los requerimientos financieros y tecnológicos para el desarrollo de los nuevos sistemas.

### Fish production and pattern of utilization

At this Conference Chikuni (1977) comments that production from tropical waters has increased rapidly and now accounts for 27 per cent of the world catch. Continued increases are expected but it is difficult to separate the future growth potential of tropical fisheries from estimates of global fish production. A figure of 100 million tons for total marine catch, given in the FAO Indicative World Plan in 1970, is probably still the best estimate of potential global production of conventional species. It is indicated that, in the future, more than 25 million tons of fish will be caught in tropical waters each year. Proper utilization to provide maximum benefit to the people living in tropical countries presents grave problems, particularly when one considers the difficulties of handling present catches under the adverse climatic conditions and the economic constraints associated with development.

Unconventional resources, ie those that at present are not caught due to lack of catching technology or suitability for processing as traditional products, have not been quantified but are potentially enormous. Table 1 shows the present and potential fish resources on a global basis and indicates the proportion currently used as food. The remainder, which is reduced to fish meal and oil, makes only an indirect contribution to protein nutrition and, regrettably, little effect on nutritional standards in the developing world is achieved through this production. Fish oil, however, is mostly converted to products for human consumption.

TABLE 1. *Present and potential fish resources: annual yields in tonnes $\times 10^6$* (a)

| *Resources* | *Used for food* | *Used for reduction etc* | *Landed, not used* | *Not landed* | *Not caught* |
|---|---|---|---|---|---|
| *Conventional resources* | | | | | |
| Freshwater | 10 | – | – | – | 5 |
| Marine | | | | | |
| Demersal | 14 | 8 | 1 | 4–5[b] | 15 |
| Small pelagic[c] | 11 | 17 | + | + | 25 |
| Others (tuna etc) | 3 | + | – | – | 2[d] |
| Crustaceans | 1.6 | – | – | + | 0.7 |
| Molluscs | 2.3 | – | – | + | e |
| *Unconventional resources* | | | | | |
| Cephalopods | 1 | + | + | + | 10 (100) |
| Mesopelagic fish (lantern fish etc) | – | + | – | – | 100+ |
| Euphausids (krill) | + | – | – | – | 50+ |

a Data on present utilization refer to 1969–71 average figures.

b Includes 3–4 million tons of by-catch in shrimp fishing and about 1 million tons of discards in other demersal fishing.

c Includes capelin.

d Smaller tunas, bonito etc.

e Potential production depending on extent of culture.

TABLE 2. *Summary of utilization of world fish production*

| | *1960* | | *1970* | | *1973* | |
|---|---|---|---|---|---|---|
| *Use* | *Tons $\times 10^6$* | *%* | *Tons $\times 10^6$* | *%* | *Tons $\times 10^6$* | *%* |
| For direct human consumption | 31.6 | 100.0 | 43.5 | 100.0 | 47.5 | 100.0 |
| Fresh | 16.9 | 53.5 | 19.5 | 44.9 | 20.2 | 42.7 |
| Frozen | 3.5 | 11.1 | 9.7 | 22.3 | 12.0 | 25.4 |
| Cured | 7.5 | 23.7 | 8.1 | 18.6 | 8.1 | 17.1 |
| Canned | 3.7 | 11.7 | 6.2 | 14.2 | 7.0 | 14.8 |
| For reduction and other purposes | 8.6 | 100.0 | 26.5 | 100.0 | 18.5 | 100.0 |
| Freshwater and diadromous | 0.1 | 1.2 | 1.5 | 5.7 | 1.8 | 9.7 |
| Marine, small pelagic | 7.0 | 81.3 | 17.5 | 66.0 | 9.7 | 52.5 |
| Marine, demersal | 0.4 | 4.7 | 1.2 | 4.5 | 1.7 | 9.2 |
| Cephalopods | 0.1 | 1.2 | 0 | 4.5 | 0.1 | 0.5 |
| Sources not specified | 1.0 | 11.6 | 6.3 | 23.8 | 5.2 | 28.1 |

A summary of the pattern of utilization since 1960 is given in Table 2. The following discussion draws on information from an FAO/NORAD meeting held in Norway in 1975 to consider expanded utilization of marine resources (FAO, 1975). The consumption of fresh fish has apparently declined but is still the principal product, representing 43 per cent of production for human consumption in 1973. It is likely that fresh fish consumption will decline, in world terms, because of more concentrated marketing methods and the need for additional processing to achieve wider distribution. Nevertheless, it is expected that in developing tropical areas fresh fish production will continue to remain important, particularly in coastal areas and along rivers and lakes.

The world-wide growth in frozen fish production, from about 10 per cent in 1960 to 25 per cent in 1973, has resulted from the extension of frozen food distribution systems. Although the production of frozen fish has not increased as markedly in the developing world, this form of preservation has contributed to a remarkable increase of fish consumption in a number of developing countries. It is most likely that production of frozen fish will continue to increase and the same tendency will be seen in the developing world both for export and domestic markets.

Canned fish production has shown a slow but steady increase; in 1973, it accounted for 15 per cent of fish for food compared with 12 per cent in 1960. This slow growth will probably continue despite the rising cost of cans and labour. Tropical countries are major importers of canned fish because it is easy to distribute and store without refrigeration. The technical complexity and scale of production required for profitability associated with high costs have generally prevented the establishment of large canning operations in developing countries to supply domestic markets. Present trends to increase production in the tropics are encouraging. One major technological advance is the availability of retortable, flexible pouches which could have enormous potential if the failure rate and cost can be controlled. More research and economic studies will be required before successful introduction but initial results are encouraging.

Although cured fish production (salted, dried or smoked) has remained relatively stable over the period, the proportion of the catch of food fish processed in these ways has declined from 24 per cent in 1960 to 17 per cent in 1973. The decline in relative importance can be attributed almost entirely to changed market and distribution patterns in industrialized countries, reflected in the growth of the freezing industry. In developing countries, where cured fish is the most important product for the lower socio-economic groups, production has continued at about the same level.

The share of the world's catch for reduction to fish meal and oil reached a maximum of about 40 per cent in the late 1960's but has since fallen to around 30 per cent in 1973–74. In some areas of the developing world, there are large, efficient fishmeal industries but there are also many small, inefficient plants which operate at a relative economic loss and which often remove urgently required protein from the local market. It is not intended to discuss the ethics or future of fishmeal production in this paper. However, it appears unlikely that the relative proportion of the catch used for fish meal will fall as long as the competitive position of fish meal in the market for animal feeding remains strong (animal husbandry and aquaculture). Given concentrated efforts, it is likely that conventional resources of small pelagic fish, presently made into fish meal, will be released for direct human nutrition while fishmeal production will make use of unexploited or unconventional resources.

## Future demands

The average consumption of fish for the whole world was 11.8 kg per caput in 1969–71. This contributed 4.6 per cent of total protein and 14.0 per cent of animal protein although there are considerable regional differences, demonstrated by Table 3. Projections of demand, based on forecasts of population and income increases, are shown in Table 4 and indicate that in the year 2000 more than 100 million tons of fish will be required for direct human consumption in order to maintain comparable standards. These projections do not take into account the possibilities for improvements in utilization technology or other factors which may improve distribution, resulting in a demand for more fish. To provide the whole of the world's population with a consumption per caput equivalent to that at present in the developed countries would require between 280 and 300 million tons per year. Even assuming consumption in the developed market economies does not rise and consumption in the developing world can be increased to the present level in the developed world, a quantity of 225 million tons would be required. Evidently, this would entail maximum exploitation of conventional resources, estimated at 100 million tons, and substantial new developments to catch and process the unconventional resources. Priority should be given to the resources where the harvesting technology is already known and where there are good prospects for increased utilization. The latent resources eg krill, mesopelagic species and oceanic cephalopods, are entirely separate groups for which both harvesting and processing technologies have to be developed.

It is obvious that vast improvements in production, handling, processing and distribution will be required to fulfill even the first objective of at least 100 million tons for human consumption by the year 2000. As this is more than double the present catches, major advances in utilization technology will be required. In tropical countries in particular, improvement of the present situation is imperative and handling the increased production, urgently needed to improve nutrition, will not be possible with the available infrastructure. Unless considerable financial resources are made available by the wealthy countries, in the form of development aid, the expanded utilization of fishery resources cannot be assured. Low-cost technology and product approaches, which can be adapted to the immediate needs of the countries, can make a considerable contribution but they are unlikely to provide protein in large quantities at low cost.

The alternative approach is the extensive introduction of sophisticated technology and mechanization provided by the developed world for the benefit of developing countries. It is certain that this will be necessary to handle and process the large volumes envisaged.

## Prospects for increased utilization

If the vast increases in fish catches become a reality, will it be possible for them to be effectively utilized by developing countries? Attempts to answer this question must divide the present traditional industries from the new, mechanized industries referred to before. For the purposes of this discussion, consideration will be limited to fish destined for domestic markets. There are many problems, such as yield and quality, that affect export industries but more attention is paid to their correction because of profit incentives. Unfortunately, this is often not the case in domestic industries which are neglected as being unprofitable and too difficult to organize.

Although there are many examples of large, single species fisheries in tropical waters, traditional industries are generally small-scale operations with small or very small vessels landing mixed catches. A most important step which can be taken to improve production from traditional fisheries is to reduce post-harvest wastage. Wastage includes edible fish which are caught but discarded at sea either because they are unacceptable to the local market or because they are unprofitable to store on board and bring ashore. Shrimp fisheries using bottom trawls, which are an unselective gear, may catch from four to twenty times as much fish as shrimp and, in most cases, the majority of this is discarded. It is estimated that over 5 million tons are wasted each year in this way. A number of economic studies have been made in the Gulf of Mexico and elsewhere but, at best, they show marginal profitability from landing these by-catches under the existing price structure and demand for fish and shrimp. In other areas, such as Indonesia, foreign joint-venture partners are required by law to land a proportion of the fish they catch.

TABLE 3. *The place of fish in consumption: average for 1964–66**

| | *Per caput consumption (kg/year)* | *Calories (per day)* | | | *Protein (grams/day)* | | |
|---|---|---|---|---|---|---|---|
| | | *Total* | *Animal* | *Fish* | *Total* | *Animal* | *Fish* |
| Developed market economies | 21.5 | 2,962 | 954 | 38 | 86.5 | 48.9 | 5.5 |
| Western Europe | 18.5 | 2,991 | 941 | 33 | 86.1 | 45.2 | 4.6 |
| North America | 14.9 | 3,166 | 1,290 | 26 | 94.0 | 66.4 | 3.2 |
| Oceania | 11.8 | 3,199 | 1,449 | 23 | 94.8 | 64.0 | 3.2 |
| Other developed market economies† | 42.4 | 2,491 | 336 | 73 | 73.6 | 26.5 | 12.6 |
| Eastern Europe and USSR | 16.5 | 3,132 | 717 | 19 | 90.5 | 35.8 | 2.8 |
| Developing market economies | | | | | | | |
| Africa | 6.9 | 2,161 | 120 | 12 | 57.7 | 9.2 | 2.1 |
| Far East | 7.8 | 1,977 | 128 | 14 | 49.2 | 7.6 | 2.4 |
| Latin America | 6.2 | 2,447 | 423 | 13 | 63.2 | 23.5 | 1.9 |
| Near East | 2.5 | 2,284 | 217 | 6 | 65.0 | 12.9 | 0.9 |
| Asian centrally planned economies | 7.8 | 2,035 | 182 | 14 | 57.8 | 8.9 | 2.4 |
| World | 11.0 | 2,367 | 392 | 19 | 65.3 | 20.7 | 2.9 |

*Excluding indirect contribution via animal feeding

†Israel, Japan and South Africa

Source: Robinson and Crispoldi, 1971

TABLE 4. *Consumption of fish and estimated demand in 1980 and 2000 due to income and population increase*

| | *Per caput consumption (kg/year)* | | | *Estimated population (millions)* | | *Total demand (tons x $10^3$ live weight)* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *1980* | | *2000* | |
| | *Actual 1970* | *Projected 1980* | *2000* | *Medium 1980* | *Variant 2000* | *Human consumption* | *Fish meal* | *Human consumption* | *Fish meal* |
| World | 11.8 | 13.3 | 16.2 | 4,575.2 | 6,640.3 | 60,969 | 33,295 | 107,548 | |
| Developed countries | 23.5 | 26.5 | 28.7 | 805.3 | 977.6 | 21,372 | 25,140 | 28,075 | |
| North America | 15.4 | 16.7 | 17.7 | 253.8 | 324.6 | 4,230 | 4,180 | 5,745 | Estimates considered insufficiently reliable |
| Western Europe | 20.3 | 24.0 | 26.6 | 383.5 | 493.8 | 9,208 | 15,710 | 11,699 | |
| Oceania | 12.4 | 13.6 | 15.2 | 18.7 | 26.1 | 254 | 375 | 397 | |
| Others | 47.5 | 51.4 | 54.7 | 149.3 | 187.1 | 7,680 | 4,875 | 10.234 | |
| Developing countries | 7.4 | 8.7 | 11.7 | 2,306.0 | 3,789.0 | 20,131 | 3,165 | 44,405 | |
| Africa | 7.1 | 8.7 | 9.3 | 371.5 | 665.7 | 3,249 | 260 | 6,191 | |
| Latin America | 6.5 | 7.6 | 9.2 | 376.2 | 650.5 | 2,854 | 1,965 | 5,985 | |
| Near East | 2.4 | 3.0 | 3.5 | 222.6 | 385.3 | 658 | 110 | 1,349 | |
| Asia | 8.5 | 10.0 | 14.8 | 1,330.3 | 2,079.5 | 13,324 | 810 | 30,777 | |
| Centrally planned countries | 11.3 | 13.3 | 18.7 | 1,463.9 | 1,872.8 | 19,466 | 4,990 | 35,068 | |
| Asian centrally planned | 8.1 | 9.5 | 14.8 | 1,079.4 | 1,414.6 | 10,253 | ... | 20,936 | |
| USSR | 23.9 | 29.7 | 37.9 | 269.3 | 327.8 | 7,996 | 2,600 | 12,424 | |
| Eastern Europe | 8.7 | 10.6 | 13.1 | 115.2 | 130.4 | 1,217 | 2,390 | 1,708 | |

Source: Robinson, 1973

Apart from under-utilization, in the sense that fish suitable for human consumption are made into animal feed, there are also high post-harvest losses of fish which spoil under the severe tropical conditions. The area where the most significant improvements could be made is the period from catching to landing. Although proper chilling would save considerable quantities of fish, all too often the infrastructure (eg ice making machinery, and insulated and refrigerated storage) is not available. In addition, the added cost of chilling cannot, in many cases, be recovered through higher prices or greater flexibility of distribution resulting from improved storage life.

Other losses are due to infestation and attack by insects and vermin. In some areas, losses of up to 50 per cent are quoted, particularly for dried products produced by a large number of widely dispersed efforts in developing countries. It is difficult to quantify spoilage and infestation losses since catch statistics are less than adequate and figures are available from only a few limited studies. A global figure, often quoted but probably subject to wide error, is 5 million tons per year.

Limiting wastage of by-catches and preventing spoilage and infestation could, potentially, make available an extra 10 million tons of fish; a high proportion of which would be in the tropics. In addition, continued fisheries development efforts, provision of new facilities and increased training programmes will stimulate production from traditional fisheries.

A great deal has been said recently about the need of developing countries for 'appropriate' or 'intermediate' technology. For intensifying traditional fisheries, this approach has merit considering the weak capacity of the poorer countries for absorbing highly complex or expensive technology. However, complete utilization of fish resources demands the development and introduction of technology which is not currently available anywhere in the world. Inevitably, this will be complex, highly sophisticated technology, involving new approaches and a completely new range of products. The developed countries have the capacity to devise and make available the required technology; they will also have the responsibility under the new economic order. The search will be expensive and continued financial support will probably be required. The objective is not to discover one single product as a panacea for all needy people but to undertake a balanced investigation on means to process large volumes at minimum cost. Small pelagic fish, representing the bulk of potential catches, are an obvious starting point but their small size, rapid spoilage and oxidation present difficulties for full utilization as human food. Intensive investigations will be required to determine in what stable processed forms these fish can be presented at appropriate costs and energy inputs. Processes suitable for bulk preparation which require further investigation are: large-scale salting and drying, preparation of powdered products, new methods of sterilization and bulk freezing.

### Costs of increased production

It is not considered possible to start new fishery enterprises without a high level of financial support and political goodwill from governments. In the developing world, multi-lateral or bi-lateral assistance funds will be required. In addition, much of the investment in harbours, roads, housing etc must be made in competition with other sectors of the economy. The profitability of the fishing industry is usually insufficient for the capital value of these public works to be charged against it.

It is difficult to estimate the investment required for substantially increasing fish production due to the large number of unknown factors. An estimate has, however, been made of the initial investment in capital equipment, manpower and technical development necessary to increase world fish production from 70 million tons per year to 225 million tons per year by the year 2000 (FAO, 1976). The figure of US $60,000 million represents about US $400 for the production of each additional ton per year. When compared with the present level of multi-lateral and bi-lateral assistance of about US $145 million per year to fisheries, the possibility of achieving vast increases seems remote. However, seen in relation to government supported, salmon enhancement programmes in Canada, the USA and Japan, where a sum probably exceeding US $1,000 million will be spent in the next five years, the cost does not appear excessive.

### Requirements for development

Provision of capital on the scale indicated above will not necessarily lead to development and increased utilization without a number of other inputs. Even if one assumes the major public works such as harbours, roads, markets and storage premises (as well as the badly needed improvements in vessels, gear and transport systems) are available, progress will not be automatic. Two most important needs which can be singled out for comment are the provision of technology and training. These two requirements are linked by the desperate need for effective extension services to reach all levels of the fishing industry.

The degree of complexity of the technology required to develop tropical fisheries has been the subject of much debate. Evidence has been presented that the introduction of modern industrial technology, to produce export products for sophisticated markets, has held back the growth of small-scale fisheries. It has become popular in recent years to suggest that 'intermediate' or 'alternative' technology will satisfy the needs of the third world. In some cases this approach has been criticised as patronizing and tending to stifle progress. The thesis advanced in this paper is that both low-level and sophisticated technology are required and that an evaluation must be made on a case-by-case basis. The proviso already stated, is that sophisticated technology to develop fish production for domestic markets in the third world will have to be financed by the developed countries. The ever-present danger of offering two technologies is the tendency to develop dual economies in the same locality. This is demonstrated by the 'haves' getting richer while the 'have-nots' contine at a subsistence level with limited government support.

It is questionable whether there is a necessity to develop specific technology for tropical fisheries. This implies a major research effort, which would have to be centred in the tropics. It is probable that enough technology is available, from developed countries, to act as a starting point for improving the situation in the tropics. The real requirement is the adaptation and selective application of this technology, bearing in mind that it must be matched to the economic and practical requirements of the recipients.

The transfer of technology can best take place through the many fish technology institutes which have been set up in developing countries. The trained staff in these institutes know the local conditions and can assess the speed at which improvements can be introduced. The FAO programme of co-operative research in tropical fish technology (James, 1976) has been set up to assist this transfer. This programme started in the IPFC region and will be extended to West Africa and the Caribbean. In essence, a group of institutes pool their limited resources to work on common problems and, at the same time, contacts are sought with institutes in the developed world to take advantage of their experience and facilities.

The delivery of the results of this programme to the actual users will depend heavily on a well trained and efficient extension service, either as part of the institute or another government department. The need for training programmes, both for extension staff and for all others involved in the industry, cannot be over-stressed. Everyone associated with providing 'fish as food' requires training; without proper training programmes, utilization will not increase substantially. If it is possible to offer training and extension advice to the rural poor, an important section of the community, the short-term effect will be an increase of production and, in the long term, socio-economic conditions will be improved.

Technology, extension and training have been singled out as among the greatest needs but there is an almost endless list of necessary provisions in a fisheries development plan. Despite all these difficulties there is no doubt that effort and investment in the fisheries sector can be justified and should be pursued as one of the cheapest ways of making more animal protein available.

## References

**Chikuni, S.** (1977) Fish resources in the tropics. In: *Proc. Conf. Handl. Proc. Mark. Trop. Fish., London,* 5–9 July 1976. London: Tropical Products Institute.

**FAO** (1975) Expanding the utilization of marine fishery resources for human consumption. *FAO Fish. Rep.*, No. 175, 47pp.

**FAO** (1976) The potential for increased production from the fisheries and the requirements for investment. Paper prepared for IBRD/FAO/UNDP Consultative Group on Food Production and Investment in the Developing Countries (unpublished manuscript).

**James, D. G.** (1976) The FAO programme of cooperative research in fish technology. Pap. pres. *1st Annu. Conf. Trop. Subtrop. Fish Technol.*, Corpus Christi, Texas, USA.

**Robinson, M. A.** (1973) Determinants of demand for fish and their effects upon resources. In: *Tech. Conf. Fish. Manage. Dev., Vancouver,* 1973.

**Robinson, M. A. & Crispoldi, A.** (1971) The demand for fish to 1980. *FAO Fish Circ.* No. 131.

# Village level processing in Zambia and the potential for improvement

**I. J. Clucas***

FAO Fisheries Development Project, Zambia

and

**S. Chamasonde**

Department of Fisheries, Zambia

## Summary

Present fish processing practices are reviewed with particular reference to the artisanal fisheries of Zambia. The constraints to rapid development are outlined and suggestions put forward as to ways in which the situation could be improved. Training fishermen in improved processing methods and the upgrading of various parts of Zambia's infrastructure are suggested as means to this end.

## Résumé

Les procédés actuels de préparation du poisson sont passés en revue en s'attachant plus spécialement à la pêche artisanale en Zambie. Les restrictions à un développement rapide sont esquissées et des suggestions sont faites sur la façon dont la situation pourrait être améliorée. La formation des pêcheurs pour l'amélioration des méthodes de préparation et le développement de diverses parties de l'infrastructure de la Zambie sont indiqués comme moyens de parvenir à cette fin.

## Resumen

Se revisan las prácticas actuales de elaboración de pescado haciendo particular referencia a las pesquerías artesanas de Zambia. Se citan los obstáculos para su rápido desarrollo y se hacen sugerencias sobre la forma de mejorar la situación. Se sugiere como medio de lograr este objetivo entrenar al personal de las pesquerías en los nuevos métodos de elaboración y mejorar gradualmente la infraestructura de distintas zonas de Zambia.

## Introduction

Zambia is a land-locked country which could almost be considered as an island. To explain this apparent paradox we need to look at the position of Zambia's major water bodies. Most of the large areas of water in Zambia are on the periphery of the country: in the north, Lake Tanganyika, Lake Mweru, Lake Mweru-Wa-Ntipa and the Luapula River; in the south and west, Lake Kariba and the River Zambezi with its tributaries. These, together with Lake Bangweulu, the Lukanga swamps and the Kafue River, constitute the major fishing grounds.

The main urban areas, and therefore the main markets, are fairly central and many miles from the fishing grounds. For instance, Lusaka and the copper-belt towns are more than 1,000 km from Lake Tanganyika. To add to this already difficult situation, the road and rail communications between the central markets and the fishing grounds are often poor. The road links, for instance, from the northern fishing areas consist of many miles of gravel road, which can be washed away or be almost impassable during the six months of rain between October and April, before tarmac roads are reached. Plans are now underway to improve this situation by surfacing some of the existing roads and making new ones to the most remote fishing villages but it will be some years before the situation will become completely satisfactory.

The rail links throughout Zambia, although fairly extensive, do not serve any of the fishing areas with the exception of Kafue Township on the Kafue River. The main north–south rail line gives a direct link between Kafue and Lusaka and further north to the copper-belt towns of Ndola and Kitwe. However, very little fish, if any, is transported along this line.

Because the road and rail communications are poor, the fish have a long and tortuous journey from the fishing areas to the central markets. During transit, poorly processed fish are lost through insect infestation, mould growth and bacterial spoilage. Transport costs are high and fish, which are already in short supply in the main markets, can be extremely expensive even when they are of poor quality. Also as a result of the supply situation, the materials considered necessary to improve the quality of dried fish are either not available or are very costly, eg salt (when available) can cost the fisherman up to six times the Lusaka price.

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* Present address: Tropical Products Institute, UK

Thus, fish is an expensive commodity where it is needed most. Policies of price restraint do little to alleviate the situation since maximum prices are not always adhered to and act as a disincentive to the fish processor to produce better quality fish and to the fishermen to produce more fish. Such policies also encourage a brisk trade in dried fish to neighbouring countries where no price restraints are in force.

## Existing methods

Due to the long distances between the fishing areas and the markets, some form of preservation is required. Ice is available in a few of the major fisheries but is only used by traders to preserve fish bought from the fishermen. The shortage of fresh fish in the markets could be alleviated by the provision of more ice plants; however, weight for weight, iced fish is more costly to transport than dried fish and this makes the fresh fish business unattractive to the small trader. As a consequence of the shortage of ice and the adherence to traditional methods, a large proportion (up to 80 per cent) of the fish is dried.

Investigation of drying methods used in fishing villages throughout Zambia indicates that a variety of techniques are in use. The methods depend, firstly, on the size and species of fish and, secondly, on the particular fishery or area in question. The same type of fish can be processed in completely different ways in different areas. For example, there are at least eleven methods of processing medium-size cichlids (mainly *Tilapia* sp.) in the five fisheries of Lakes Mweru, Mweru-Wa-Ntipa, Tanganyika, Bangweulu and the Lukanga Swamps (Clucas, 1976). To illustrate this, three methods are given for processing cichlids:

(1) In Mweru-Wa-Ntipa, cichlids are scaled, gutted and cleaned but not split. They are then sun dried for about 20 minutes to remove the surface moisture and smoked for two to three days. The fish are turned over when the lower side is dry and has stopped dripping.

(2) Also in Mweru-Wa-Ntipa, the same fish are scaled and split dorsally along the backbone, the guts are removed and the body cavity cleaned. They are sun dried for at least three days on raised drying racks and are then briefly smoked to give them a brown colour.

(3) In the Lake Mweru fishery, however, cichlids are scaled, split and the body cavity cleaned. They are then sprinkled with dry salt and layered with more salt in a 44 gallon oil drum until it is full. Sacking is placed over the top of the stack of fish and the lid of the drum replaced. Large stones are placed on the top of the stack to press the fish. After a period of up to four days, the fish are removed from the pickle that has formed and sun dried for one to two days.

It can be seen that there are wide variations in the drying methods used. They range from what is basically a smoking technique to a sun drying method and, finally, a dry salting method.

The reasons for using the various techniques are often difficult to find. Fishing and fish processing methods are handed down from father to son over the generations and so are 'traditional' in the true sense of the word. However, it is not difficult to see the reason behind the dry salting technique. Dry salted fish is particularly popular in Zaire and Zambian fishermen produce this sort of fish entirely for export across Lake Mweru into Zaire. There is an equally brisk trade in the opposite direction of Zairie beer which is popular in Zambia. The tribes along the Luapula River and around Lake Mweru are descended from Zairie tribes which moved into Zambia many generations ago, probably bringing this traditional processing method with them.

The various processing methods were originally developed to preserve fish for the local market. The methods are quite adequate to supply the local housewife with a ready supply of 'relish'. In this situation, the fish are required to be in good condition for only about two weeks and little handling is involved.

With the growth of the large urban centres in the copperbelt and Lusaka areas, profitable markets have developed at a distance from the fish producing areas. The fishermen and fish processors, seeing the potential of these markets, entered the business for profit; they started to produce more dried fish but continued to use their traditional processing methods because they knew no other. Many of the traditional methods do not produce a dried fish which will withstand the rough handling involved in transport or remain in good condition for the longer periods necessary to reach the new markets. In consequence, a significant quantity of fish is spoilt by the time it reaches the market. Many methods produce a hard and brittle product which can become broken into small fragments during transport. Dermestid beetles, moulds and bacteria also attack the poorly dried fish during the long periods between production and consumption. It is usually the fish trader who suffers directly from this loss but he will take expected losses into account when bargaining with the fisherman to buy the fish and he will elevate the price to the consumer to take into account the actual losses experienced. This tends to lower the income of the fisherman and raise the price of fish on the markets.

### *Smoking*

Although there are wide variations in the processing methods used throughout Zambia, there is marked uniformity in the type of equipment used for smoking. The traditional smoking unit resembles a 'table'. The 'table top' can be made of natural material such as wood or reeds (woven together into an open work mat); or chicken-wire or expanded metal. This 'top' is commonly about two metres long by one metre wide and is supported about 70 cm above the ground by wood or metal poles at the corners. The fire is laid on the ground directly below the fish which are placed on the 'top' for smoking. Occasionally, vertical mud walls are built around three sides of the structure between the ground and the edges of the table top. These walls help to contain the fire and produce a fire box rather than just an open sided fire place. It is usual for the whole structure to be built inside a grass hut.

This type of smoking unit is widespread throughout Zambia and has a number of disadvantages:

(1) The fire is extremely difficult to control; this wastes fuel and the end product is very variable. Some fish may be burnt and charred whilst others may be poorly dried and spoiled. The quality of the final product is difficult to predict.

(2) There is a fire hazard with so much combustible material surrounding an open fire.

(3) The thatched grass hut gives some protection from rain but is not completely storm-proof.

(4) In addition, wood for fuel is difficult to obtain especially in the swamps of Lukanga and Bangweulu. Fishermen have to buy wood and transport it long distances across the swamps in dug-out canoes.

### *Sun drying*

It is the exception rather than the rule that raised drying racks are used for the sun drying of fish. Most fish are dried directly on the ground or on woven reed or grass mats laid on the ground. Where drying racks are used, they are usually flat-topped and constructed from wood.

### *Dry salting*

Salt is used extensively only for the dry salting techniques of Lakes Mweru and Mweru-Wa-Ntipa, one of which has already been described. All of the fish processed using dry salt is exported.

The use of brine before drying is extremely rare. Brine is not used traditionally and there is a common belief that even slightly salted fish will not sell. Also, salt is extremely difficult to find in most fisheries and, where it is available, it is very expensive. For these reasons the fishermen have been reluctant to use brine although its use would mean a better yield and would reduce losses (eg mechanical damage, insect infestation etc) during transport.

## Improving the situation

### *Training programmes*

Most developing countries have training programmes designed to help the rural community improve its standards of living. These are often in the form of 'extension services' aimed at the peasant farmer or fisherman. The aim of extension services is to help the villager to help himself and the aim of every extension worker should be 'to leave the community in a better state than when he found it'. The extension worker usually has a general knowledge covering a particular field; however, he must have easy and direct access to experts in other fields in case problems, which he is not capable of dealing with, arise. The extension worker must ascertain what is best for the community in which he is to work and he must also realize that there are many constraints which tend to prevent any improvement. It is most important that the results of his efforts should be quantifiable; for example, he should be able to demonstrate that any innovation he may suggest to the fisherman or his family will show some benefit.

Not only should an extension worker be able to give advice and demonstrate improvements in his own particular field but he should also be able to see what is necessary for the improvement of the community as a whole. For instance, they may require a clinic, a water supply or better sanitation, a primary school or advice in growing crops. The worker may not be able to do any of these things himself but he should know who to contact in order that something may be done.

Before an extension worker can go out into the villages and start training others, he will need training himself. It is in this area that many difficulties begin to arise. To determine the most appropriate training for an extension worker, we need to know the sort of problems he is likely to come across in his work and the training organizers must, therefore, be familiar with the village situation. In Zambia, this involves visits to many different areas and many miles of travelling. From research in Zambia, from the experience of others in similar situations and from his own experience, the trainer should be able to ascertain the sort of improvements that are most likely to be of use to the fishermen. This ground work is most important otherwise the extension worker may get into the field and find that what he has learnt is of little value. Once the methods to be taught (eg improved processing, net mending, etc) have been decided, a syllabus can be drawn up. The detail and background to be included depends to a large extent on the education and the previous experiences of the extension worker. This brings us to the next point for consideration.

Whom does one select for training? In most cases the prospective extension worker will be someone who is already employed by the fisheries department. He will, therefore, have some knowledge of the fishing industry and should know something about the fishery in which he is going to work. Before undergoing any training, the extension worker must also realize that his life in the field will not be easy; extension work entails spending many months away from home and family. He will be working without direct supervision most of the time and must, therefore, be conscientious and hard working. He must also be able to get on with people without losing his patience and drive. He will be working in a strange environment where he will be unknown and his presence may be resented by some members of the community which he is trying to help. He must not be 'put off' by the initial reactions of the group in which he is to work; he may find them hostile to begin with but, if he is doing his job properly, they should accept him and gain confidence in him. However, when improvements can be introduced and are accepted by the community extension work can be very rewarding. It is extremely important, therefore, that the right sort of person is chosen for extension work.

### *The infrastructure*

Training programmes designed to introduce improvements to the fishermen cannot be effective without considering more general problems, eg improvements to the infrastructure of the country. Included in this are communications (road and rail links), ice plants, market facilities and general service to the fishing community (eg provision of salt). Most of these points have already been considered but the supply of ice has only been mentioned in passing.

*Supply of ice*: At present there are three ice plants which provide ice directly to the fisheries; two are block ice plants, one at Kashikishi on Lake Mweru and the other at Mpulungu on Lake Tanganyika and there is a newly installed flake ice plant at Sumbu also on Lake Tanganyika. In addition to Lake Mweru, the Kashikishi plant also serves the Lake Mweru-Wa-Ntipa fishery; since traders have to transport ice a distance of 100 to 150 km the final selling price of fresh fish from Lake Mweru-Wa-Ntipa is obviously affected. Lake Bangweulu, the Lukanga Swamps and the southern fisheries have no direct supplies of ice. Parts of the Kafue River, closest to Lusaka, use ice from Lusaka but not in large quantities.

Very little ice is used directly by the fishermen. Ice is normally bought by traders who tranship fish to the markets. Zambia Fisheries and Fish Marketing Corporation (ZF and FMC), who own the three ice plants, also use large quantities for the preservation of fish in the market centres. Fishermen do not find it worthwhile to ice their fish since there is no ready market for fresh iced fish in the fishing areas and they do not have transport to the central markets. This situation may change when the ZF and FMC bring into effect a policy of buying fresh fish from the fishermen before marketing.

It is difficult to come to any conclusions about the siting of new ice plants in Zambia. The fresh fish trade is not constant and relies on the trader who moves from one area to another depending on the fishing activities. An example of this fluctuation in trade will illustrate the point. During the early sixties, an ice plant situated at Sinazongwe on Lake Kariba was producing as much ice as it could sell and was making a profit. Catches of fish, however, dropped considerably in later years and traders stopped coming to the plant to buy ice. The plant soon became uneconomic and was closed. The central location of an ice plant to serve more than one fishery may solve this sort of problem but transport costs must be considered carefully.

The siting of a plant at Kafue Township would probably be feasible. This would serve the Kafue fishery, and traders heading for Lake Kariba from the main market centres could collect ice on their way, as Kafue is on the main southern road. Namwala, further up the Kafue river, would be another possible site for a plant to serve the important fishery along this part of the river.

The northern fishing grounds are comparatively well served with ice plants but an additional installation at either Kampinda or Nsama on Lake Mweru-Wa-Ntipa would seem feasible. This would save time and money for traders because they would not have to bring ice from Lake Mweru, as mentioned earlier.

The use of ice in the swamp fisheries of Bangweulu and Lukanga is not feasible. The fishermen live on floating islands often many miles from the mainland. Collecting ice every two or three days and delivering iced fish would require much time and effort and would cut down valuable fishing time. At present, the fish are dried or smoked on the floating islands and stockpiled until sufficient is ready to justify a journey to the mainland markets.

### Improved methods

With this background a few specific areas which require attention in Zambia can be considered.

#### *The use of salt*

A number of workers in Zambia have advocated the introduction of brining as a preliminary to drying or smoking. (Watanabe, 1971; Watanabe and Dzekedzeke, 1971; Watanabe and Cabrita, 1971). However, at present salt is not available in most fisheries. In any plan to improve the amount and quality of dried fish on Zambian markets, it is a first priority that salt must be made available to the fisherman at a price he can afford. The supply of salt could either be part of the service provided by the Department of Fisheries or by a parastatal organization such as the ZF and FMC. This important activity cannot be left to private traders because salt is a bulky and relatively cheap commodity which does not provide the profit incentive of other goods.

It will be very difficult to persuade a fisherman to use salt (or brine) until it is readily available. The most efficient extension team can travel in the area demonstrating the use of salt, which they have brought with them, but they will have no effect if, after they have left, the fisherman is unable to buy salt. For years, salt has been put forward as a possible solution to the fish wastage in Zambia but the problem of providing the fisherman with salt has still not been solved.

#### *Smoking*

The smoking equipment used in the fishing villages of Zambia is remarkably uniform. Therefore, the successful introduction of an improved smoking kiln in one fishery may indicate the usefulness of the same design in other areas of Zambia. Of the improved smoking devices which have been tested, that introduced in the Ivory Coast by Christensen (1965) seems particularly suitable for Zambia. The 'Ivory Coast Kiln', as it is often called, can be constructed relatively cheaply using, in part, local materials. The principles of the smoker are obvious and are based on the same concepts as the traditional Zambian kiln. These factors make the kiln easily accepted by the fisherman. In addition, it has the following advantages over the traditional 'table' smoker:

(1) It uses less fuel.

(2) It can produce a uniform product because the fire is controllable and the heat and smoke distribution are uniform.

(3) It is weather-proof.

(4) It takes up less ground space than a traditional smoker of the same capacity.

Former foreign experts working in Zambia have advocated the use of the 'drum-smoker' in Zambia's fishing villages (Watanabe and Joeris, 1976). In the experience of the authors, this type of smoker is not very well received in most communities for the following reasons:

(1) Oil drums and stove piping are required for construction; these are expensive and not available in most areas.
(2) The drum has a very limited capacity. Often, only one large fish will fit on a tray making the capacity of the kiln only six or seven fish.
(3) The principles on which the smoker works are not immediately obvious and do not relate directly to the design of the traditional kilns.
(4) Welding is necessary for construction; most fishermen do not have access to welding machinery.

Some of the disadvantages of the 'drum-smoker' have been overcome by the introduction of the 'mud and pole' smoker*. This smoker has the same basic plan as the drum-smoker and is used in the same way. However, the smoking chamber is made from locally cut poles covered with mud. The chamber can be made to any size, within reason, thus overcoming the small capacity of the drum-smoker. The techniques used in construction are familiar to most African villagers and should present no difficulties. The smoke pipe can also be constructed from cheap local material; it can be made by digging a trench in the ground and covering it with sticks and then mud to form a tunnel. The fire box is less easily constructed from local materials and is best made using half an oil drum as with the drum-smoker. The fire box is the only component that may not be easily obtainable and which may be expensive. The mud and pole kiln is cheap to construct and overcomes many of the disadvantages of the drum-smoker (Clucas, 1976).

These smoking techniques have been demonstrated to fishermen by the authors. The Ivory Coast kiln seemed popular and there should be little difficulty in promoting its use through training and extension programmes. As with any village development programme, the introductions must be cheap and simple and the fisherman must be convinced of the usefulness of the new method.

## Conclusions

Zambia's fish processing industry is at a fairly low level of development in the fishing village situation. Much fish is wasted during transportation and in the villages as a result of poor drying techniques. Efforts are being made to improve the situation by introducing better processing methods to the fishermen through extension services. Before these improved methods can have any real effect on dried fish production some major problems have to be overcome. Improvements in the road and general communications network need to be made and salt has to be brought to the fishermen in sufficient quantity and at a price that he can afford. Ice plants and the purchase of fish from the fishermen by the Zambia Fisheries and Fish Marketing Corporation will improve the fresh fish supply.

## References

**Christensen, E.** (1965) *La conservation du poisson.* Rapport au Gouvernement de la Côte-D'Ivoire. FAO/EPTA Report 2032.

**Clucas, I. J.** (1976) *Present fish drying techniques in Zambia and suggested improvements.* FAO Technical Paper to Fisheries Development Project FI/ZAM 73/009/3 Rome: FAO.

**Watanabe, K.** (1971) *Improved method of preparing dried sardine from Lake Tanganyika.* Ministry of Lands and Natural Resources, Department of Wildlife, Fisheries and National Parks. UN/FAO Central Fisheries Research Institute, Zambia.

**Watanabe, K. & Cabrita, F. J.** (1971) Directions for the preparation of salted and dry-smoked fish. *Fish. Res. Bull. Zambia,* **5**, 225

**Watanabe, K. & Dzekedzeke, O.** (1971) Taste preference of Zambians for various types of dried and smoked fish. *Fish Res. Bull. Zambia,* **5**, 199.

**Watanabe, K. & Joeris, L.** (1967) *How to smoke fish in a drum-smoker.* Ministry of Natural Resources and Tourism, Department of Game and Fisheries. UN/FAO, Central Fisheries Research Institute, Zambia.

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* A leaflet on the mud and pole fish smoking kiln can be obtained from I. J. Clucas, Tropical Products Institute, or see Clucas, 1976.

# A tropical African artisanal lake fishery: Lake Rugwero, Rwanda*

**I. G. Dunn**
Aquatic Biological Consultancy Services Ltd., UK

**Summary**

The economy and the organization of a typical tropical, small-scale, artisanal fishery are described. This fishery is an important national resource, which produces the bulk of the fish on the urban markets of Rwanda (approximately 232 tonnes per year). It represents a stable, labour-intensive industry involving small capital investment. An analysis is made of the income of those employed at all stages of the industry (range US $7 to $22 per month). The present (1972) state of the fishery is discussed with comments and suggestions for the lines along which this type of fishery can be managed and improved.

**Résumé**

L'économie et l'organisation d'une pêche typiquement tropicale, de petite taille et de type artisanal, sont décrites. Cette pêche représente une ressource nationale importante qui produit la majeure partie du poisson des marchés urbains au Rwanda (232 tonnes par an). Elle représente une industrie stable, impliquant une activité intensive et nécessitant peu d'investissements en capitaux. Une analyse est faite des revenus des personnes employées à tous les stades de cette industrie (moyenne mensuelle US $7 à $22). L'état actuel de la pêche (1972) est discuté avec des commentaires et des suggestions pour les directives permettant à de tels établissements de pêche de s'organiser et de se développer.

**Resumen**

Se describe la economía y la organización de una típica pesquería artesana tropical, a pequeña escala. Esta pesquería constituye un importante recurso nacional, que produce la mayor parte del pescado comercializado en los mercados urbanos de Ruanda (232 toneladas al año). Representa una industria estable, con empleo de mano de obra intensiva, pero pequeña inversión de capital. Se realiza un análisis de los salarios de los empleados en todos los estadios de la industria (variables entre US $7 y $22 al mes). Se discute la situación presente de la pesquería (1972), con comentarios y sugerencias sobre las directirces a seguir para mejorar la gestión de dicha pesquería.

## Introduction

The Lake Rugwero fishery provides the bulk of the fish available on the markets of the Rwandan capital, Kigali. It is typical of many small lake fisheries in developing countries in that it provides a high class protein product, which is acceptable to local consumers, by means of a simple, yet efficient, system of catching, processing, transporting and marketing. This type of industry represents an important stage in the maximum utilization of a developing country's resources. These fisheries, with their low level of capital investment and their intensive use of manpower, can be very efficient in economic, social and biological terms. A careful appraisal of this type of fishery is, therefore, essential before industrial techniques (usually patterned on those of developed countries) are substituted for the existing patterns of fishing, transport and marketing.

## Description of the fishery

Lake Rugwero, on the frontier of Rwanda and Burundi, is a shallow (5m), highly productive lake with a total area of approximately 100 km$^2$, of which 20 km$^2$ are Rwandan territorial waters. Its markets are located at a distance of approximately 90 km and are connected to the lakeside landings by a network of dirt roads and tracks. The fishery is based on the exploitation of stocks of *Sarotherodon* (*Tilapia*) *niloticus* with an estimated harvest of 232 tonnes fresh weight per year (see Table 1).

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* This study is based on investigations carried out between July and October 1972, as part of the United Nations Development Programme Project RWA/68/004, and refers to the conditions prevailing at that time.

TABLE 1. *Production of* Sarotherodon (Tilapia) niloticus *from the Lake Rugwero Fishery (1972)*

| *Supplied to* | | *Quantity (tonnes/year, fresh weight)* |
|---|---|---|
| Kigale Market: | fresh | 27 |
| | smoke dried | 81 |
| Garde Nationale | | 72 |
| Kibungo area | | 26 |
| Local consumption | | 26 |
| *Total* | | 232 |

Total number of fish harvested: 1,643,000/year
Total retail value: 5,749,000 FRw/year
(1 Rwandan Franc. FRw, = US $0.01)

Approximately 100 fishermen work on the open water of the lake (both Rwandan and Burundan waters), fishing at night from dug-out canoes and using floating gill nets of 76 and 89 mm stretched mesh. An estimated eight nets, 50 m long and 26 meshes deep, are used by each canoe. The catch is delivered to the landings or collected on the lake by fish processors or other dealers. Approximately 4500 fish are landed each day with an average fresh weight of 140g each and almost 90 per cent of the fish arrive at Mugina and Giseke, the two landings near Nemba.

After landing, the fish are cleaned and sold to the bicycle transporters who take them, in basket loads of 300 to 600 fish, to the market in Kigali. This is a journey of one to one and a half days.

### *Fish processing*

The facilities for processing the fish are very primitive. All washing and gutting is carried out at the lake side. The processors squat in the mud and both they and the fish are exposed to the sun. Fresh fish are simply gutted and washed in dirty water, they are acceptable at local markets for up to 36 hours.

Smoke dried fish are similarly washed, gutted, scaled (the gills are not removed) and laid out on the ground to dry in the sun for an hour or two. They are then tightly packed head down on a grill over a fireplace constructed from an oil drum and mud bricks. About 600 fish are then half-cooked and half-smoked for 4 to 5 hours. Two of these smokers remain of the three constructed by a European who attempted to commercialize the landing in 1969. Some fish are smoked over primitive pit fires. The smoke dried fish are badly preserved and are acceptable on the market for 3 to 5 days.

### *Employment in the industry*

There are four groups employed: fishermen, processors/fish buyers, transporters/sellers, and other traders. The industry gives full-time employment to an equivalent of 145 men. In fact, some of the men are employed part-time and the benefits of the industry are shared between approximately 190 men.

*Fishermen*: At any one time, there are approximately 100 fishermen at work on the lake. About 20 are based on the two landings (Mugina and Giseke) and approximately 80 (who probably work 75% of the year) are in temporary camps by the lake. In this way, the fishing is shared between approximately 130 individuals.

*Processors/fish buyers*: There are 15 men permanently employed in collecting the fish from the fishermen. The fish are delivered to one of the two main landings where they are gutted and scaled. Approximately 75% are then dried and smoked. These men sell the fish directly to the transporters. The processors and their families are a permanent, stable community at the landings.

*Transporters*: At any one time, approximately 30 men are employed in transporting fish to the market (principally Kigali). The fish, both fresh and smoked, are carried in baskets on the backs of bicycles. Any one transporter apparently works for only eight months of the year. Therefore, approximately 45 men obtain a part of their livelihood in this way.

*Other traders*: About three times each week the bulk of the catch is collected direct from the fishermen on the lake to supply nearby military establishments. Occasionally, merchants use vehicles to fetch small loads of fresh fish to markets in Kigali.

### *Incomes*

The net incomes of those employed in the fishery are given in Table 2. These estimates ignore the consumption by the Garde Nationale which has recently started to trade directly at the lake. The expenditure of the various sectors of the fishing industry is presented in Table 3.

TABLE 2. *Income of employees of the Lake Rugwero fishery (1972)*

| *Employment* | *Net monthly income per man (FRw)* | *Total monthly income for industry (FRw)* |
|---|---|---|
| Fishermen | max. 1,397 | max. 139,700 |
| | min. 722 | min. 72,200 |
| Processors | 1,841 | 27,615 |
| Transporters | max. 2,232 | max. 66,960 |
| | min. 1,182 | min. 35,460 |
| Other traders | not known | not known |
| *Total* | | max. 234,275 |
| | | min. 135,275 |

Note: The use of maximum and minimum values reflects the seasonal variations in the catch with the concommitant variation in the prices of the fish.

TABLE 3. *Expenditures generated by the Lake Rugwero fishery (1972)*

| *Employment* | *Items of expenditure* | *Total value/year (FRw)* |
|---|---|---|
| Fishermen | Nets | 633,600 |
| | Canoes | 120,000 |
| Processors | Wood | 14,220 |
| Transporters | Bicycle purchase | 119,880 |
| | Bicycle maintenance | 86,400 |
| | Baskets | 6,400 |
| | Food/lodging en route | 259,200 |
| *Total* | | 1,238,700 |

The analysis of income for fishermen is as follows:

*Catch*

| | |
|---|---|
| Delivered to Nemba landings | 3,500 fish/day |
| Delivered north to Kilbungo area | 500 fish/day |
| Consumed locally around the lake | 500 fish/day |
| Average total catch | 4,500 fish/day |

*Work force*

| | |
|---|---|
| Total number of fishermen | 130 men |
| Number of fishermen working on any one day | 100 men |

*Income*

| | |
|---|---|
| Average catch/man/day = $\frac{4,500}{100}$ = | 45 fish |
| Selling price of fish (fluctuates with season) | 1.0 to 1.5 FRw |
| Average income/man/day | 45 to 67.5 FRw |
| Average gross income/man/month | 1,350 to 2,025 FRw |

*Expenditure*

| | | |
|---|---|---|
| Depreciation of nets* | | 528 FRw/month |
| Depreciation of canoe† | | 100 FRw/month |
| Total expenses | | 628 FRw/month |
| NET MONTHLY INCOME | max. | 1,397 FRw |
| | min. | 722 FRw |

* Each fisherman has an average of 8 nets at 200 FRw/net, with useful life of 3 months.

† Assume a canoe costs 2,400 FRw and has a life of 2 years.

The analysis of income for processors, who also act as fish buyers, is as follows:

*Through-put*

| | |
|---|---|
| Average number of fish handled/day | 3,500 fish |
| Number of days each month when fish are available | 18 days |
| Number of fish handled each month: | |
| total = 3,500 × 18 = | 63,000 |
| fresh | 15,750 |
| smoke dried | 47,250 |

*Work force*

| | |
|---|---|
| Total number of permanently employed | 15 men |
| Each man handles $\frac{63,000}{15}$ = | 4,200 fish/month |

*Income*

| | |
|---|---|
| Each fish is sold to the transporters with a price increase of 0.5 FRw. | |
| Average gross income/man/month = 4,200 x 0.5 = | 2,100 FRw |

*Expenditure*

| | |
|---|---|
| Cost of smoke drying 600 fish (wood) | 15 FRw |
| Each man smoke dries 3,150 fish/month | |
| Cost of wood = $\frac{3,150}{600}$ x 15 = | 15 FRw/month |
| Rent of canoe to collect fish (18 days) = 18 x 10 = | 180 FRw/month |
| Total expenses | 259 FRw/month |
| NET MONTHLY INCOME | 1,841 FRw |

The analysis of income for transporters, who also act as market sellers, is as follows:

*Through-put*

| | |
|---|---|
| Average number of fish handled each day | 3,500 fish |
| Number of days each month when fish are available | 18 days |
| Number of fish handled each month: | |
| total = 3,500 × 18 = | 63,000 |
| fresh | 15,750 |
| smoked | 47,250 |

*Work force*

| | |
|---|---|
| Total numbers of transporters | 100 men |
| Number of transporters working on any one day | 30 men |
| Each man handles $\frac{63,000}{30}$ = | 2,100 fish/man/month |

*Income*

| | |
|---|---|
| Average selling price of fish in market | 3.5 FRw/fish |
| Average gross income/man/month | 7,350 FRw |

*Expenditure*

| | | |
|---|---|---|
| Cost of fish at landing | | 1.5–2.0 FRw/fish |
| Cost of 2,100 fish/month | | 3,150–4,200 FRw |
| Assuming each man makes 6 trips each month | | |
| 6 days at market (tax 30 FRw/day) | | 180 FRw |
| 6 trips, loss of fish (at 3.5 FRw/fish) | | 480 FRw |
| 6 trips, maintenance of bicycle | | 240 FRw |
| 6 trips, extra expenses on food and lodging | | 720 FRw |
| Baskets, cost/month | | 15 FRw |
| Capital depreciation/month on bicycle (4 years life) | | 333 FRw |
| | | 1,968 FRw |
| Total expenditure | | 5,118–6,618 FRw/month |
| *Net monthly income* | max. | 2,232 FRw |
| | min. | 1,182 FRw |

**Present condition of the fishery**

The organization of the fishing industry is relatively satisfactory both socially and economically. The benefits of the industry are dispersed among a large number of people involved in fishing and the associated trade. The system is labour-intensive and low in capital investment, giving employment to approximately 190 men on a full-time or a part-time basis; this creates an average income of 1274 FRw per month.

It is unlikely that the harvest can be increased by more fishing pressure (through the increase in fishing units, improvement of techniques etc) since it appears that the fish stocks are already being exploited at near optimum levels (FAO, 1974). It is probable that any investments designed to increase the fishing pressure would be wasted.

At present, the system is stable although this stability could be threatened by the recent entry into the industry of merchants with motor vehicles and powered boats. This represents a high-capital, low-labour element which is able to, and sometimes does, monopolize the total catch on two or three days of each week. The result is that on some days there is no work available for the processors and the transporters. There is a risk that, if this tendency continues or increases, the present stability could be destroyed. This risk is particularly important to the processors who are a full-time working community at the landings with no other livelihood to fall back on. If this group should be dispersed, the fishermen would be faced with a market outlet monopolized by a small number of merchants.

### Suggestions for the improvement of the fishery

It is important that any considerations for the better management of the fishery and the improvement of the product take into account problems that are peculiar to developing countries. The construction of a framework of rules and regulations, in the absence of an authoritative extension service able to offer advice and to enforce controls, is useless. At Lake Rugwero, there is the additional difficulty that any legislation must be enacted and enforced by both the Rwandan and the Burundan authorities. It is better for future relationships between the fishing community and the authorities that no regulations be made rather than controls be imposed and flagrantly evaded. For the present, it would be better to let economic forces control the rate of exploitation of the lake, advice and economic aid being provided where necessary.

The present products (smoke dried or fresh) are acceptable at the market place. In making any investment or management programme aimed at improving the quality of the product, it should be borne in mind that an increase in quality may not be reflected in an increase in the price the consumer is prepared to pay. This aspect of consumer acceptance is often overlooked when advice on product quality is based on the experience of consumer preferences in developed countries.

Trials have been made to produce a smoke dried fish with a longer storage life (up to six months instead of less than one week). The trials were successful but revealed a consumer resistance to the product because it differed in appearance from the smoke dried fish previously on sale in the market. An advantage of a longer-keeping product is that wastage could be avoided on those occasions when a surplus of fish is landed. Also, the availability of a longer-lasting product would make possible the use of production from other lakes where, at present, the lack of communication prevents frequent visits from transporters.

There is much scope for improving the hygiene and decreasing the general squalor that surrounds the main landings. It is impossible to produce a product that will keep well under these conditions. The implementation of any improvements at the landings will depend upon the processors. They form the one group permanently resident at the landings and the one group that would have any motivation for 'investment in the future' by making improvements. The minimal requirements for the improvement of such a fish landing, typical of thousands throughout the underdeveloped world, are outlined in Table 4.

**TABLE 4.** *Proposals for improving a typical Lake Rugwero landing (Mugina)*

| *Area of improvement and present conditions* | *Proposed improvement* | *Estimated cost (FRw)* |
|---|---|---|
| *Landing* | | |
| A gap in the papyrus fringe. Water and mud up to 1 m, foul with fish wastes and human excrement. All fish transported through this mess. | Clearing the papyrus to make a good entrance. Provision of a wooden landing stage, with gangway to the shore. | 10,000 |
| *Processing area* | | |
| Fish are cleaned by processors etc, squatting in mud at the lake side. | Provision of a 'processing floor' with a roof. | 30,000 |
| *Processing (preparation)* | | |
| Water from lake edge is used for cleaning fish and utensils. Waste is thrown into this water. | Provision of a simple water supply by means of a small pump taking water 10 m away from lake edge. Simple water storage tanks. | 15,000 |
| *Processing (smoke drying)* | | |
| Old mud brick smokers and pit fires are now used. | Eventual construction of improved smokers to improve product. | Nil |
| *General community hygiene* | | |
| The community consists of 15–20 permanent families and ±30 transient individuals. There are primitive shelters available for the transients but no sanitary facilities. The present shelters are remains of an old processing area. | Better water supply (see above). Provision of a latrine and a general renovation of the old constructions to provide a cleaner environment. | 10,000 |
| *Total* | | 65,000 |

## Acknowledgements

I wish to thank the Director of the Department of Fisheries of FAO, Rome, for permission to use the data presented here. Also, I am grateful to M. Spiridion Nsengiyumva of Service de Pêche et Pisciculture, Ministere de l'Agriculture et de l'Elevage, Rwanda, for his aid in the field.

## Reference

**FAO** (1974) *Rapport au Gouvernement du Rwanda sur la pisciculture et la developpement des peches, etabli sur la base des travaux de I. G. Dunn.* Programme des Nations Unies pour le developpement, (Rapport) No.AT 3244, 39 pp. Rome: FAO.

# Discussion

From comments made in earlier sessions, it was obvious that this topic would arouse considerable interest and the Chairman, therefore, suggested that the various aspects of fisheries development dealt with in all nine papers be considered in a single discussion period. In order to provide a framework for the discussion, the Chairman proposed the following topics:

- small-scale fisheries (socio-economics; fishermen/trader relationships; financing etc)
- extension and training (small-scale, and other, fisheries)
- co-operation and assistance (technology co-operation; co-operation and co-ordination between donors)
- trends in fish utilization (costs of processing; demand and nutritional aspects).

## Papers 1 to 9

The major part of this extremely lively discussion centred on small-scale fisheries. Many features of the artisanal fisherman and fishery were discussed with particular interest being expressed in socio-economic aspects of their development. Considerable discussion also took place on the second topic in relation to small-scale fisheries. Extension and training were considered essential for development and an integrated approach is needed. It was pointed out, however, that 'development' may not always be readily accepted; the question of incentives was raised. In the remainder of the discussion, technology co-operation and co-operation between donors was touched upon. There was no discussion on the fourth topic.

At the suggestion of the moderator, **Clucas** spoke briefly to his paper and pointed out that there are more traditional methods of processing fish than those described; most are based on local demand and are handed down from generation to generation. The urban population is drawn from all areas of the country and there is, therefore, a demand for a wide range of traditional products in urban areas. In recent years, the market has increased in size and, since many of the products are not suited to transport or long periods of storage, it has been necessary to consider whether a few standardized methods should be developed or whether each traditional method should be improved.

**Dunn** noted that the cost of improving the fishery on Lake Rugwero, outlined in his paper, was US $650. Nothing had so far been done and he felt that a project costing say US $65,000 was more likely to be implemented. He made a plea for micro-projects in developing countries stating that a 232 tonne fishery was important to Rwanda.

The Chairman then allowed **Faubeau** a few minutes in which to answer the queries, raised informally and during the meeting, on the preparation of nuoc-mam in the Ivory Coast. **Faubeau** mentioned that almost all species of fish and shellfish are suitable as raw material; offal and poor quality frozen fish can also be used. Salt is mixed with the raw material; this stops putrefaction and allows chemical changes to take place. The only other 'additions' are rice and molasses. Concrete, or glass-lined vats, are suitable for large-scale production, but, on a small scale, fermentation is carried out in wooden barrels. Nuoc-mam is sold as a liquid which is bottled, sometimes after filtering, in glass or plastic containers. The fish oils can be skimmed from the surface of the vats and sold separately. Finally, **Faubeau** stressed the high content of essential amino acids, minerals and vitamins in nuoc-mam.

The main discussion opened with a comment from **C. E. P. Watson** that fisheries development authorities are often confronted with conflicting policies. On the one hand, fish production and the fisheries contribution to GNP must be increased and, on the other hand, maximum employment levels in the fishing industry must be maintained. He felt that the development of trawling, indicated in the paper by **Mathotho** and **Rogers**, should be encouraged. The conflict between developing the artisanal and industrial fisheries is, said **Lawson**, well documented and can be resolved only in cost benefit terms. She felt that the Conference as a whole had perhaps a misleading concept of the artisanal fisherman. Many are also farmers and other members of the family generally contribute to the total income. The fisherman may not wish to change his location nor spend more time fishing.

**Taylor-Thomas** was then asked by the Chairman to outline experiences in The Gambia in developing the artisanal fishery. The introduction of purse seining, which is not very different from the traditional ring netting, was considered essential for development. Trials were successful and the fishermen adopted the method using enlarged and modified versions of local canoes, powered by outboard motors. With the acceptance of the purse seine it is hoped that there will be little or no resistance to the introduction of larger 13 m inshore vessels working purse seines. A revolving loan scheme is in operation to provide outboard motors and gear. The Chairman asked how the increased catch is being dealt with. In reply, **Taylor-Thomas** said that, of the two major pelagic species, *Sardinella* is not well-liked and will probably be frozen for export and bonga, which is landed in large quantities, is cheap, widely distributed throughout the country and satisfies the local demand for fresh marine fish; some bonga is smoked for export. He mentioned that new, under-exploited species of fish, such as black groupers and snappers, were also landed.

Following on, **Levy** raised the question of whether the artisanal fishermen ceases to be 'artisanal' when he finds a regular buyer or is taken over by a large concern. Although the sturgeon fishery (begun in the 1890s) along the south coast of the Caspian Sea is now a highly industrialized enterprise, the fishermen themselves have been little interfered with. Three processing stations, with ice making, freezing and cold storage facilities, serve the 21 fishing units; the catch is collected daily by speedboats.

Commenting on **Lawson**'s statement that the artisanal fishermen are often farmers, **Golley-Morgan** pointed out that in The Gambia/Sierra Leone region there are two types of fishermen: full-time fishermen, whose income is solely from fishing and who stop fishing only when the weather is unsuitable (June–August), are mainly along the Atlantic coast; part-time fishermen who fish for about five months of the year and farm for the rest of the year.

**Dunn** then proposed that the small-scale industry should be considered a valuable element of the country's economy and not something that has to be 'corrected' as soon as possible. He pointed out that the artisanal fisherman is a 'flexible unit', requiring low capital investment, which responds to economic pressures such that best use is made of the fish stocks and the resource is protected.

Turning to the paper by **James**, **Dhatemwa** mentioned that in many developing countries (for example, Uganda) the priority is, he felt, for equipment and not manpower; qualified and experienced local staff are available, but much-needed spares are not. Furthermore, many of the young so-called experts from overseas are lacking in experience. In reply, **James** commented that the choice between the supply of expertise or equipment by donor agencies is difficult; there is no hard and fast rule. Each case must be evaluated on its merits and the decision must concur with the wishes of the recipient government. If a country has no trained fisheries personnel and if fisheries development is Government policy, then expatriate expertise is necessary. On this point, **Dunn** stressed the need for local extension officers to work in the field. In his experience, many young men in developing countries were reluctant to work under field conditions. This lack of local experience is one of the reasons expatriates are imported.

In relation to possible development of the artisanal fisherman, **Clayre** asked the opinion of the meeting on consumer resistance to the introduction of new, efficient species to fish farming. **Krone** mentioned that Governments are reluctant to introduce exotic species and fish farming will, therefore, tend to concentrate on proven species. He also mentioned the recent conference on aquaculture in Japan. **Dunn** added that, with the right approach and with patience, it is possible to overcome consumer resistance to certain foods. In Rwanda, a taboo food was converted to a 'traditional' food through sensitive extension work.

There followed comments from **Haywood** on the **Lawson** and **Shaw** papers. He felt that social opportunity costing methods upset normal economic thinking. Estimating the economic value of a fishery is difficult; most small-scale fisheries are 'losers' but employment and other factors have to be taken into account. On the role of the middlemen, he felt that social cost benefit figures require further analysis. **Haywood** said he could not agree with the approach taken in the **Shaw** paper. Firstly the analysis does not take into account the time value of money nor does it consider elements such as seasonality in terms of, for example, plant utilization. Finally, he referred to the question of the 'weak' market for the small processor. In reply, **Shaw** said that all capital expenditure is discounted and, on the second point, he felt that a stochastic approach to, for example, seasonality would not significantly alter any overall conclusions. **Shaw** agreed that the small processor is in an intrinsically weak marketing position, which can be partly overcome by good organization. However, an analysis of the demand side of the equation was not part of the paper's function.

On distribution, **Hastings** commented briefly on the successful solution to the problems of the Lower Shire swamp fishery in Malawi. The 2500 fishermen catch some 15,000 (short) tons per year but, without a central market, distribution was difficult. The Fisheries Department wished to bring the benefits of a fixed landing to the area. A 2000 ft canal was constructed to link the marsh with the new landing, which provided facilities for gutting, smoking and drying, and storing the fish. Benefits accrued to the fishermen, who had an assured market with fish prices tending to rise through trader competition, to the traders, who could produce a better product more efficiently from the new kilns, and to the consumers, who had a steady supply of better quality fish.

At the Chairman's suggestions the topic for discussion turned to extension and training. **Sagua**, concerned that the rural/urban drift will, over the years, deplete the numbers of artisanal fishermen, felt that something must be done to improve their status. He proposed an integrated approach to the development of small-scale fisheries. This should incorporate fishing, fish culture/farming and livestock (eg pigs, chickens or ducks) production. Extension personnel should, he felt, work in teams to teach the integrated approach. Further to this proposal, **Lawson** said that, since most artisanal fishermen (Sierra Leone and The Gambia may be an exception) are involved in other income-earning activities, mostly farming, fisheries development should be related to these; hence, it would be beneficial for extension officers to operate in an integrated programme covering both agriculture and fisheries. She commented that agricultural extension has been so much more successful than fisheries and, therefore, a broader based training, integrating fisheries extension with agricultural extension, should be considered. **Herzberg** also thought that fisheries should be dealt with as a branch of agriculture. He felt that the fisherman/farmer system should be encouraged; trash fish and non-commercial species should be used in the family, or local, unit for raising poultry and as manure for growing fruits and vegetables. To his suggestion that farmers could become part-time fishermen, **Moal** agreed for freshwater fisheries but was unaware of any farmers becoming marine fishermen. **C. E. P. Watson** then endorsed the point made by **Cole** on the importance of having the 'right kind' of extension officers who are willing and able to work very closely with the fishermen.

On a cautionary note, **Squires** commented that too much emphasis on training may lead to a further reduction in numbers of rural fishermen by making them 'professional'. The rural fisherman is adapted to his way of life and has little need for extra cash; this may, however, be realized by catching extra fish. He felt that small, village aquaculture schemes (for seaweeds, crustaceans, fish etc) could be very beneficial in the rural set-up. Limited fixed target incomes are, said **Hastings**, a key problem in development. In the Lower Shire marsh fishery, an improved cast net, that would catch five times as much as the traditional gear, was given to a fisherman for a month's trial. Rather than catching extra fish, he caught the same amount as the man fishing with a traditional net but fished for one-fifth of the time. His income target was self-limited and he had no desire for extra money. The Chairman agreed: he had observed this sort of situation on many occasions. An agricultural irrigation scheme in Nigeria was, said **Sagua**, comparable. The farmers worked harder when given an incentive; in this case they wanted to buy a bicycle. The desire to buy material goods, to educate children etc should, he felt, lead to higher productivity. There must, however, be a steady market for increased catches. Finally, on the topic of extension and training, **Cayetano-Reyes** commented that an extension officer has to be a jack-of-all-trades; he may have to act, on occasion, even as a doctor or nurse.

The third topic for discussion was introduced by the Chairman who asked the SIDA (Swedish International Development Authority) representative how she regarded the co-operation between different agencies, bi-lateral and multi- bi-lateral. **Liljeberg** mentioned that SIDA works with most large organizations and private agencies as a financing body for projects. In her 11 years of experience co-operation can, on the whole, be regarded as good. **Liljeberg** asked the Chairman for his opinion on SIDA/FAO co-operation; **Krone** said that he has always found the multi-bi system works successfully. **Vidot** added that he favoured the multi-lateral approach which, he felt, helped to prevent empire building and improved efficiency through competition.

Further to **Dunn**'s plea, made at the beginning of the discussion, for the funding of micro-projects, **Hjul** said that many projects failed because they were too large or lavish; he strongly agreed with **Dunn**.

Comments on the **Mathotho** and **Rogers** paper, which provides an excellent example of co-operation and co-ordination between multi-lateral and bi-lateral agencies and the Government, were made earlier in the discussion, and are included here. **Dhatemwa** asked the size of the hotel market for smoked bagrus fillets and mentioned that, in Uganda, bagrus is regarded as a delicacy but is always sold head-on. In reply, **Mathotho** said that approximately one ton of fillets is supplied each month.

Referring to the boat ownership scheme, **Sabri** made comment on the burden of repayment, the repayment schedule, selection of the fishermen to own the boats, sharing of profits and the problems of converting a fisherman to a boat owner. He asked whether the artisanal fisherman is interested in boat ownership or a stable income. In response, **Mathotho** said that the landing and market are controlled; the men are paid monthly after deductions have been made for loan fund repayments, fuel, servicing etc. Fishermen are selected for boat ownership and are trained in the necessary skills. This system, as described in the paper, appears to work very well to the benefit of all concerned.

There was insufficient time for discussion on the fourth topic, trends and fish utilization, the subject of the paper by **James** and **Krone**. The Chairman mentioned that a recent FAO/NORAD paper, 'Expanding the utilization of marine fishery resources for human consumption', contains many points on this topic.

# Session 9

## Close

**Friday 9th July**
**Afternoon**

Chairman
D. N. F. Hall
Ministry of Overseas
Development
UK

Rapporteur
N. R. Jones
Tropical Products Institute
UK

# Commentary on the Conference

**N. R. Jones**
Tropical Products Institute, UK

## Introduction

At the official opening of the Conference, we were congratulated on our sense of timing in coming together at a time when pressures on fisheries resources and food supplies generally have been increasing. Our twin aims have been to consider how fish in the tropical countries might best be used to human advantage; and how the industry, particularly the producer, could be encouraged in its efforts through the benefits arising out of improved technology and marketing. In so doing, we have had a unique opportunity, as delegates from a large number of developing countries, from the international agencies and from countries with aid programmes, to put forward ideas for furthering the development of tropical fisheries.

The organizers of the Conference thought that it might be useful, in this closing session, to attempt a distillation of our views on the several matters that we have been discussing. What follows must, of necessity, be a personal view but I acknowledge with many thanks the sterling work of the speakers, moderators and rapporteurs under the guidance of our distinguished Chairmen. I have of course drawn very heavily on these sources.

## The resource

As Mr Judd told us, the value of the world catch of tropical species for 1973 (the latest figures available) was US $1110 millions. To this, the post-harvest system after landing added a value of some 20% within the countries of origin.

In the first of the working sessions of the Conference, we were given a more detailed assessment of the tropical resource, and its prospects, by FAO. It was noted that the Western Pacific and Indian Oceans were of high potential and that exploitation was, on the whole, light or moderate; the Atlantic, however, was moderately exploited. The impression was gained that shrimps and cephalopods, in coastal regions, and large tunas seem to be fully exploited but there is potential for further exploitation of skipjack and, in some areas, of other pelagic species.

In discussion, it emerged that delegates viewed the projections with a degree of caution and, in so far as the FAO suggests that some figures are over-estimated, it would appear that this is warranted.

Some discussion centred on developing aquaculture in Africa, particularly in the context of dam building projects which were taken to offer extensive opportunities in the Sahel, but a cautionary note was introduced in the light of African experience within the last 15 to 20 years. It was noted that such development optimally employs more labour than marine fisheries and a lower level of investment is required.

## Background to technological development

Together with the resource paper in the first session, we had a brief introduction to the technical sessions which have occupied most of the Conference time. Questions were posed about the differing market requirements for urban as opposed to rural markets and for export industries and home markets; and how these could best be met by small and larger scale industries. Specifically, problems were raised about public health requirements, the transference of technology, the integration of fisheries industry with food industry and the place of fisheries development in the wider development process. No attempt was made, of course, to arrive at any conclusions at this early stage of the Conference but attention was directed particularly to the situation of the artisanal fisherman and the sociological constraints under which he operates. These sociological factors were stressed more generally in considering technological developments, not least in those involving co-operation from agencies outside the country.

## Quality factors in marketing and acceptability

In the second session, and in a number of other sessions, the Conference considered both the scientific background to quality control/assurance and the increasing impact of standards legislation. It concentrated mainly on wet fish, shellfish and crustaceans but there was a keen recognition also of the recent problems of the freezing industry.

The Conference considered the general biochemical and microbiological background to quality control, the public health considerations and the problems of inspection and standards. It attempted to relate these to the wider developmental considerations. Certain doubts were raised about the relevance of the more scientific contributions which leant rather in the direction of attempting to extrapolate from temperate to tropical fisheries. It was generally agreed that information which might be applicable to the improvement of commercial tropical fish processing is sparse. Clearly, further information is required from carefully directed research.

It was apparent from our discussions that serious public health hazards can arise from the consumption of uncooked fish products and that the dangers of contamination can be very high under some of the infrastructural and sociological conditions applying in some tropical developing countries. This has led to the rejection of produce, particularly prawns and frogs legs, in the international market.

Some doubts were expressed about the needs for, and relevance of, standards but the Conference recognized that international markets would be lost if produce failed to meet the requirements of importing countries. Some delegates were of the view that it is invidious to distinguish standards separately for developed (export) and developing (home) markets for tropical seafoods; the Conference recognized that it is for individual countries to determine the requirements for their home situations.

With respect to inspection and quality control, a consensus emerged that inspection should be mandatory rather than voluntary and that it should be integrated with the extension function. A number of individual countries' inspection systems were discussed and it became clear that no one system is optimal to all situations; for instance, the placement of the inspectorate within the governmental system depends very much on local circumstances. There was a large measure of agreement that the efforts of inspection/extension systems should be concentrated on the smaller companies. It emerged clearly that certain countries with established export industries had no effective system of inspection and that they lacked the background of staff and resources to develop inspection and quality control services immediately. Obviously, urgent action is required if export industries are to survive in such situations.

Notwithstanding the scarcity of information in some areas of spoilage microbiology and biochemistry, a number of guidelines for action emerged.

Firstly, through the UN and other international systems, codes of practice are available. These, applied with due regard to the limitations of current knowledge enable a reasonable approach to be made in meeting the standards of the export market. For instance, the introduction of improved chlorination techniques can lead to considerable improvement in the microbiological quality. Further guidelines related to specific problems of application of quality assurance and inspection technology in subtropical and tropical developing countries.

(1) There is a considerable requirement for 'objective' tests aimed at minimizing subjective judgements that are readily disputable. There is a considerable measure of agreement on the need for microbiological standards for pathogens. With respect to the spoilage (as distinct from the pathogenic) microflora, there is evidence that the tropical situation differs markedly from the temperate. Attempts at standardization based on temperate/cold fishery experience should therefore be viewed with caution. With respect to the chemical methodologies, further evidence was presented to the Conference of the advantages of the hypoxanthine test.

(2) Contrary to experience in many cold/temperate fisheries, the benefits of gutting in meeting conventional standards for many tropical species are questionable.

(3) The cleaning of equipment and the introduction of partial sterilization techniques, such as radiation, are complex microbiologically. If handled incautiously, such technology can encourage the more active 'spoilers' and pathogens at the expense of a relatively harmless microflora.

(4) Generalizations on quality assurance procedures for even closely related species can be dangerous when unsupported by first hand evidence of experience in local industry.

(5) Serious safety/inspection problems can be presented by toxic fish in some tropical locations. In the absence of rapid chemical methodology, animal testing such as that carried out in Japan appears, in the absence of no new developments as reported to the Conference, to be the monitoring procedure to adopt.

(6) Countries still require to keep the mercury problem in mind. Although the Conference heard a plea for less rigorous standards, there appears to be little likelihood that importing countries will accept such a position.

(7) There is concern in certain fisheries about the development of a hydrocarbon pollution problem in high spillage-risk areas. This should be kept in mind in the development of inspection systems.

## Handling and marketing of fresh fish

Not unexpectedly perhaps, there was a considerable overlap between the section of the Conference session relating to this subject and that on quality and its control referred to above.

The Conference did not arrive at any agreement on generally applicable optimal technologies for handling and marketing. Indeed, the keynote was the variability of experience in different geographical situations. There was, however, general agreement on the very high priority which should be awarded to small-scale fisheries and an acknowledgement that programmes of development should be designed and carried out with careful consideration for the socio-economic environment. The objectives should be simplicity and cheapness. Needs and solutions must be carefully evaluated locally. Nevertheless the session was useful in documenting the variety of experience. There were for instance excellent reports on the development of floating wharf techniques and on optimal capacities of ice plants in different situations. It was clear that much remains to be learnt about the economic use of ice; for instance, for some species considerable delay periods may be permissible before icing. No clear consensus emerged on the relative merits of flake ice and block ice; similarly, advantages of refrigerated sea-water or chilled sea-water systems over icing were not firmly established except perhaps for oily pelagic species for which the uptake of salt was not considered to be a serious problem.

In the course of the wider coverage of marketing, the Conference reviewed a number of local industry studies with particular emphasis on small-scale development. There was a particularly useful paper giving a detailed cost and viability study based on FAO experience in the Caribbean, together with some conjectural guidelines for the operation of wholesaleing and retail outlets.

Taken together with discussion in a later session, a consensus emerged that the middleman can have a useful, stabilizing influence in small-scale fishing industry development and that his elimination (as advocated by one delegate) would be damaging in many country situations.

## Frozen fish technology and marketing

The quality assurance and handling procedures discussed above for wet fish, prior to freezing, were taken to be appropriate. The Conference assumed tacitly that time/temperature tolerance criteria for tropical species in cold storage were not likely to be more demanding than those of others.

Within the terms of the wider remit of the Conference to look to the interests of the artisanal fisherman, some reservations were expressed about the relevance of the frozen industry to his problems. However, large numbers of small-scale fishermen are working in some countries to supply frozen fish factories; in other countries, larger scale industrial fisheries for frozen fish production are being developed.

The advantages of frozen products were catalogued: long storage life; stability of supply and, possibly, price; rationalization of distribution; standardization; flexibility of retailing; possibilities of more advanced promotion. However, the Conference recognized the difficulties of consumer acceptability that commonly arise within the developing countries (as elsewhere) and the considerable processing and distribution costs. In tropical situations, the enhanced shelf life commonly found in chill storage can negate some advantages claimed for frozen fish in cold/temperate fisheries.

Somewhat tentatively, a consensus emerged that frozen fish can indeed offer certain economic advantages over fresh or dried fish production. Better organization of production and marketing of other types of product (such as 'stock fish' equivalents) could, however, improve their relative positions in the market but the competitive position of frozen fish is itself likely to improve as products diversify and poor quality is eliminated.

The Conference discussed the considerable difficulties that have arisen in certain fisheries attempting the development of export markets. The lack of tradition and infrastructure and the particular problems of integrating the small-scale fisherman into an acceptable freezing industry were well illustrated. The similar position with respect to the development of a freezing industry for home consumption was illustrated by the development of highly industrialized fish freezing in West Africa from which complaint had arisen about the lack of spin off to the remainder of the industry. The Conference was informed that future developmental plans in at least one West African country will seek to redress this position.

As in so much of the Conference, it became clear that, in the short and medium term, the prospects for the home and export industries for tropical fish differ. While home markets and development are affected by the factors indicated above, prospects for export appear to be generally poor. Local demand must usually be satisfied first and investment potential is limited. From the importer's standpoint, a paper from a UK company was of particular interest: demand (approximately 5000 tonnes per annum) was taken to be for the immigrant population and was considered unlikely to increase much. Difficulties of packaging, presentation and transportation all indicated needs for improvement.

## Fish meal, fish silage, canned and other processed fish

The large number of contributions reflected the interest in developing countries in making better use of species of low commercial value, or of low quality and only partially utilized, for the production of easily distributed stable products.

To consider firstly the contribution of dried products. We heard an excellent review of meal manufacture from the International Association of Fish Meal Manufacturers and this stimulated a most useful discussion. The Conference noted the unsuitability of some dried meals for the international market and received advice on optimal handling for tropical conditions. Both the stickwater and gaseous effluent problems were discussed in relation to the growing consciousness in less developed countries of environmental pollution. The recovery of dehydrated stickwater saves considerable quantities of protein that would otherwise be wasted and cause offence. There is a developing market for spray-dried stickwater. Appropriate combustion treatment was recommended for the removal of gases but it was also noted that it is necessary to minimize offence from the reception areas of the plants.

There was some useful discussion on microbiological and fire hazards in the fishmeal industry and it was noted that trade specifications, which insist on the use of imported packaging materials, result in serious financial constraint on the development of industry. It is apparent from the general discussion that storage and transportation have been presenting considerable problems in exportation and that, while fat contents above 10% have advantages in terms of feed energy for local utilization, there are still many objections to increasing permissible fat contents for export. The Conference received excellent advice on optimal packaging, storage and antioxidant regimes.

During reports and comments on fish protein concentrates, the Conference noted a good acceptance of FPCs type B, relatively unrefined by comparison with the high-priced type as canvassed extensively until recently. While some West African consumer resistance was noted, there appear to be prospects for the further use of trash fish for FPC production in India. Under the right local conditions, projects for the cheaper FPC-type products appear to be not unpromising.

Considerable interest was expressed by the Conference in the further development of traditionally dried products. These should retain certain textural properties which are important factors in acceptability. Practical difficulties of drying and smoking, and some solutions, were discussed. The avoidance of infestation by insects and the improvement of efficiency in the utilization of wood fuels were of particular interest. In this respect, a Guyanese approach to the avoidance of initial contamination by screen solar drying appeared to offer good prospects for utilization elsewhere. Additionally to such technology, well-established combinations of good housekeeping standards in the processing and marketing channels, together with the correct use of safe insecticides such as pyrethrins (or in certain circumstances salt), offer good control. It was clear from the contributions of some African delegates that there is cause for concern about uncontrolled use of insecticides. From the general discussion it was apparent that, while progress had been made in the design of kilns, further work is required urgently on their design in terms of fuel economy.

There was much discussion also, in a number of sessions, on liquefied fish products and dehydrated products deriving from them. The products are characterized by varying degrees of protein hydrolysis in the presence of salt, acids or fermentation products at concentrations which suppress the development of undesirable spoilage microfloras. Some of the technologies are well established and the products present no problems of acceptability, at least in the countries of origin. Other products, such as those which are liquefied and then dried with carbohydrate fillers, are less well established or experimental.

There appear to be prospects for the upgrading of traditional salt-based fish sauce technology. There also appear to be good prospects, both at the level of rural technology and on the larger industrial scale, for the development of acid ensilages for tropical conditions. However, if the speaker may be permitted to inject a cautionary note, he would have liked to have seen some long-term feeding trials reported for some of the silages; and, while perhaps it would be dangerous to stray too far into the field of nutrition, it may be useful to remind the Conference that there is evidence that high levels of protein lysate feeding are undesirable. Low-cost lysates, however, appear to have an important role for the future, particularly for animal feeds at relatively low levels of supplemental feeding. In this respect, also bearing in mind the somewhat controversial discussion of salt-based lysates in the Conference, it may be noted that while their role in human nutrition is well-established it is characterized by supplemental use at low intakes of salt. Further reports on the acceptability, safety and economics of lactic fermentation products prepared under tropical conditions are awaited with interest.

At a number of points throughout the Conference sessions, discussion developed on fish minces; although hardly novel products in some countries, their potential is just beginning to be realized in others. Modern deboning technologies have added a new impetus to the work and raw minces (suitably preserved in, for instance, frozen form) offer prospects for marketing in a wide range of product categories depending on the starting material and the preferences of consumer populations. The acceptability of some salted or fermented minces or patés is well proven; the Conference was also told of a number of other interesting developments such as fish 'jams'.

## The shrimp/prawn fisheries and the by-catch problem

Some technical and socio-economic factors are not peculiar to prawn fisheries and were discussed broadly across the sessions of the Conference. Such fisheries are categorized, however, by the necessity to maintain the microbiological quality and acceptability of a small volume of high value shrimp under difficult climatic conditions, and by the associated capture of a relatively large volume (up to 85%) of 'trash' fish.

The Conference was presented with useful backgrounds to the development of successful industries in India and Guyana. Fuel costs and low production had presented difficulties additional to those of quality assurance, which had diminished (in Guyana) with the advent of the refrigerated hold. A paper from Malaysia illustrated the continuing quality problems encountered in several countries. The situation is often exacerbated by the intrusion of technically ill-informed entrepreneurs.

Other papers informed the Conference of the current importation requirements in developed countries and the fundamental microbiology of the contamination/control processes. It is clear that public health authorities in the importing countries view the position with concern. This has resulted in a 'distortion' of what has been taken by some to be commercially the optimal pattern of imported prawns in the raw condition towards the importation of cooked products in the interests of safety. There was critical discussion on the variability of microbiological standards for different seafoods. A public health authority delegate briefly and pungently drew attention to cross-examination hazards and brought this part of the discussion to a close. Requirements for satisfactory quality assurance are well established (eg the FAO Code of Practice): failure to apply them will result in loss of the market.

Another recurring theme, touched upon in a number of sessions, was the use of the by-catch, much of which is returned to the sea currently, being taken to be a possible microbiological contaminant of the shrimp and uneconomic to land and market. There is no single solution to this 'problem'. It is apparent that some of the by-catch could be chilled or frozen and landed and marketed conventionally, although not necessarily economically. The use of other technologies (drying, ensilage, minces etc) offers promise also.

## Some wider implications of fisheries development

The penultimate session of the Conference aimed at a synthesis of technical considerations with others in fisheries development. While not altogether successful, it illustrated some factors that contribute to success. It touched upon artisanal fisheries, individual case studies in fishing industry development and their associated economics.

The Conference discussed the difficulties of upgrading the performance of traditional, small-scale fisheries. It was agreed that the appropriate technologies must be, of necessity, simple. Modernization could well be initiated by the use of small mechanized boats with adequate space for proper handling and iced storage of the catch. A simple landing point with a supply of ice is required to maintain quality and could, as one case study on Lake Rugwero showed, provide an excellent return for a low-cost input.

A paper dealing with fisheries development on Lake Malawi pointed out that success resulted from the close collaboration between the Government and the aid agencies, bi- and multi-lateral, concerned. There was general agreement that such projects should be encouraged.

On the other hand, it was considered that short projects taken up piecemeal and lacking integration frequently fail. These, particularly (but not exclusively), tend to fail to take into account the culture and customs of the fisherman and his customer. Not for the first time in the Conference, the need for thorough socio-economic appraisal of projects was emphasized. In this respect there is, for instance, a need to examine the role of the middleman. Although often assumed to be harmful, he appears, in some cases, to be beneficial.

There was considerable discussion in a number of sessions about extension services, which were taken to be the key to successful fisheries development. As indicated above, they can include an inspectorate function. Paramount, however, is the need for extension workers (whether indigenous or expatriot) fully to understand, and to integrate with, the fishing communities.

An interesting presentation from the FAO, on developments in fish utilization, pointed out that tropical waters, which now contribute more than a quarter of the world's production, are expected to yield 25 million tonnes per annum. While recognizing a need for both simple and higher level technologies, it questioned the need to develop specific technologies for tropical fish and, since this would require a major, expensive research effort, FAO suggested the adoption and selective adaptation of technology already available from developed countries. In so far as other contributions to the Conference had indicated innate differences between certain tropical and temperate species, it may be concluded that the key to such an approach would be the selectivity of the adaptation in the light of circumstances: a need for further research appeared to be clearly established.

With respect to transference of technologies, there appears to be some difficulty in obtaining processing costs appropriate to conditions in some less developed countries. Large economies of scale are possible in fishmeal enterprises; this is less well established for canneries where overriding local factors can be important: each case needs to be looked at individually, however.

The major impression left by this session were the great diversity of conditions encountered in tropical fisheries development work and the need, above all else, to consider local conditions carefully. It was apparent that a solution that works well in one area may fail in another. Other impressions that remained (notwithstanding the possibilities for technology transfer and new product development) were of the continuing importance of a large range of traditional products in countries such as Zambia, and of the possibilities that undoubtedly exist for product improvement.

Finally, it was clear that the supply of trained technologists and administrators (to service the industry, the extension services and government) continues to be a major bottleneck in fisheries development. Also it emerged that some of the training available in the developed countries is of doubtful significance to tropical fisheries development. Training, particularly for the extension services, should be directed towards the technical and socio-economic conditions of the countries seeking development and often this training will best be carried out locally.

## Summary of major conclusions of the Conference

(1) Fisheries development should be undertaken on an integrated basis. Local socio-economic conditions may well determine the appropriate technology, which often involve the direct support of the artisanal fishery.

(2) Transference of technology from temperate/cold-water fisheries to tropical fisheries is only practicable to a point. Extreme caution should be exercised in attempting to apply experience gained from one situation to another and even from one species to another.

(3) There is a pressing need for more fundamental information about the microbiology, biochemistry, composition and handling/processing characteristics of tropical species.

(4) Quality assurance and control present major problems in tropical fisheries development. Some solutions are known; others remain to be established.

(5) Quality standards are primarily matters for local governmental control, although international guidance is available. Export standards, however, are set effectively by importing (developed) countries. These standards have been rising but can usually be met. Particular difficulties are encountered, however, in

labour-intensive food processing industries in developing countries and governments may be faced with difficult policy decisions.

(6) Governmental quality control may often be associated advantageously with an extension function.

(7) Significant reductions in wastage (including that of the shrimp by-catch) are possible through the application of known technologies. Further research is required to optimize individual solutions.

(8) There is a serious lack of trained fish technologists in many developing countries. Much training currently available in developed countries is irrelevant to problems in ldcs. Generally, local training is to be preferred and should be strengthened.

# Discussion

This final discussion, stimulated by **N. R. Jones**' commentary, the previous session and, inevitably, the whole Conference, was fairly short and concentrated mainly on various aspects of fisheries development.

The discussion opened with a warning from **C. E. P. Watson** on the potential dangers, when integrating fisheries with agriculture, of fishery matters being subject to control and frustration by the often more influential agricultural authority. The Chairman agreed and on this point **D. James** added that, despite the ever-present danger of fisheries remaining under the control of agriculture, improvements to rural fishing and small farming projects may require both agricultural and fisheries experts.

There followed a short discussion on the question of providing incentives to encourage fishing effort (already discussed in Session 8). Commenting on fisheries development plans aimed at improving the life-style of the fishermen and improving the national diet, **Clayre** stressed the need for careful thought and consideration to be given before implementation. If increased fishing effort can be achieved only by persuading the fishermen to covet consumer goods (ie incentives such as bicycles, radios etc) in order to raise their ambitions for more income, important aspects of their life may, he felt, be destroyed. The Chairman noted that the extra income rapidly goes back into circulation and tends to benefit the community as a whole; he added that perhaps the fisherman's wife is 'driving him on' to earn more. An example of how the introduction of an incentive will over-come lack of motivation was given by **Hastings**. About 20 years ago, a Zambian company was set up to buy fish from Lake Tanganyika for sale in the copper belt. After six months, the supply of fish ceased and investigation showed that the fishermen had no desire for the extra money because there was nowhere to spend it. This negative incentive to catch fish was overcome by opening a shop; trade then continued as before.

**Okedi**, referring to a comment (made in an earlier discussion) that extreme caution must be exercised in mixing fish technology and social welfare, felt that he could not agree. **Bligh** apologized for his perhaps misleading statement and explained his point: he could not accept the concept that the quality of seafoods should remain low so that poor people can afford to buy them since this would prevent development. From **James**, the meeting heard that FAO recognizes that the demand for technological improvement should be generated by the community and technology should serve the interests of the community. **Hastings** stressed the need for a socio-economic (as well as a traditional technical) approach to fisheries problems. If, for example, outboard engines are introduced to a small, finite artisanal fishery, those fishermen who can afford the engines may be more efficient but this could be at the expense of the traditional fishermen who may well find themselves unemployed. The Chairman commented that integrated programmes are desirable but sometimes difficult to expedite. This is, said **Bligh**, precisely his point: in mixing technology and social welfare, caution is required since there are times when the two are incompatible.

The Chairman noted that there are three fundamental ways of improving the earning power of the artisanal fisherman: by increasing the quantity of fish caught, by improving the quality of fish and by reducing operating costs. There is also the possibility of training such fishermen to operate in newly developed fisheries, eg the transition from inshore to off-shore fishing. To the suggestion from **A. H. Jones** that the promotion of fish and fish products could be considered as an additional way of increasing income, the Chairman replied that this would fall into his first category. It was pointed out by **Bligh** that the ultimate fish resource is finite and must, therefore, be fully utilized. At present, excessive quantities (up to 50% in some cases) are wasted through spoilage etc and **Bligh** considered that our duty as fishery technologists is to eliminate this loss through technological application and development. Although increased costs would be incurred, there is potential for the fishermen's landings to go twice as far. The middlemen would doubtless make more money but **Bligh** hoped that benefits would also accrue to the artisanal fishermen.

During the discussion, a few delegates made a number of isolated points. Wishing to correct the impression that he might have given from his earlier comments (in Session 8) on the need for equipment, not manpower, **Dhatemwa** said that experts are welcome and he expressed gratitude for all the bi-lateral aid that Uganda has received from many countries. The Fisheries Training Institute was provided through UK co-operation and Uganda now has a highly trained fisheries manpower; they can, for instance, build ferro-cement boats but spares are needed. **Golley-Morgan** mentioned that it is preferable to teach people living in rural areas (who may not readily accept new ideas) by example rather than precept. Some years ago, Ghanaian fishermen settled in Sierra Leone and, before they were repatriated, the Sierra Leonean fishermen had started to build Ghanaian canoes and were using Ali or ring nets for *Sardinella* and bonga. Previously, the fishermen had only used short drift gill nets; *Sardinella* fishing was unknown. **Cayetano-Reyes** noted that, at this Conference (as at a similar one held in Costa Rica last year), there are no fishermen represented; the delegates are all Government servants etc who tend to bring out the fishermen's dirty linen. They are the people fishing not us! He requested that FAO or TPI should invite fishermen to future meetings of this kind.

Commenting on the lively exchange of ideas and information at this Conference, **Peterkin** hoped that delegates would not forget what they had heard and learnt and he suggested that TPI should try to promote further interchange of information between the developed and developing countries in the longer term; a regular forum or meeting should be established. **N. R. Jones** replied that TPI is prepared to consider the implications of this proposal which, if accepted, would involve a lot of work and organization. From **James**, the Conference heard that FAO is promoting the exchange of information between fishery technological institutes; among other 'vehicles' is an International Directory of Fish Technology Institutes.

It was suggested by **Sagua** that the 'essence' of the Conference could, in his view, be summed up as working towards a better quality and greater quantity of fish, a better life for the fishermen and a wider distribution of fish from the tropics throughout the world. The Conference has (he said) highlighted some of the problems of small-scale artisanal fisheries and has offered ideas for their solution but the problems are not solved by discussion; he, therefore, stressed the need for continuing investigation. Also, **Sagua** congratulated TPI on organizing this very useful and successful Conference. Following on, **Disney** praised the 'project' approach as being highly beneficial; a successful project provides the stimulus for further development (this was illustrated by the FAO project on Lake Malawi referred to in Session 8). **Hjul** commented that the title of the Conference adequately embraced the theme; one should not, he felt, be tied down by too specific a theme. **Okedi** also congratulated TPI on their organization of this highly successful Conference (the first major meeting on post-harvest aspects of tropical fisheries) and on their hospitality. With reference to future meetings, he proposed that the next one should be five years hence.

The vote of thanks to TPI was given by **Peterkin** on behalf of all the delegates. From the papers and discussions which have been heard during the past week, he was encouraged that the world food crisis may not in fact be as disastrous as prophesized. Whilst the role of bodies such as TPI and FAO is in diseminating information, all the delegates have the responsibility of taking what they have seen, heard and learnt back to the fishermen. Finally, **Peterkin** stressed the importance of co-operation in upgrading artisanal fisheries.

# Concluding remarks

Ladies and Gentlemen, Dr Spensley has asked me to apologize for his unavoidable absence and to offer these final words on his behalf.

A conference such as this can only be a success if a large number of people have been involved in its inception, planning and presentation. We hope that this has been a success and are very grateful to the delegates who travelled from so many different parts of the world to make contributions.

Our thanks are due to the members of staff of TPI who assisted with the planning and running of the Conference. The task of reading and editing more than 70 papers is a formidable one as is, of course, the organization generally. However, the effort has by no means been restricted to TPI; we have been most fortunate in that many people outside the Institute have made major contributions to this occasion and I wish, before we close, to acknowledge our most sincere gratitude to them.

First, the members of our programme committee who contributed such excellent ideas in the planning stages as well as during the Conference itself. We are also grateful to the people who have guided our discussions by acting as chairmen, rapporteurs and moderators during the week's sessions. The high standard set has contributed much to the smooth running of the Conference.

We were pleased to receive such strong support from the international organizations, almost all of those connected with fisheries technology being represented here. We were, of course, particularly pleased that FAO have given us so much of their time, both in the preparation stages and here at the Conference. Our friends and colleagues from the Torry Research Station and the White Fish Authority have our special thanks for their help at all stages of planning and also for their direct contributions to the meeting.

During the week, many of you have visited Billingsgate Market. Those who went much enjoyed the visit and have asked that I convey their thanks to the administration and staff of the market.

Inevitably, it is difficult for some people to find the funds to attend international meetings such as this. Our thanks, and those of the delegates whose attendance they supported, are due to IDRC of Canada, NORAD of Norway, the Commonwealth Foundation, the Commonwealth Secretariat, the British Council and the Institute's parent body Ministry of Overseas Development.

Next week, a number of you will be touring the Humber area and Aberdeen with us to see something of the British Fishing Industry. TPI is grateful to the many people who are making this possible, particularly the companies concerned, the Torry Research Station and the White Fish Authority (whose Industrial Development Division has made the visit to the Humber area possible).

The gratitude of all of us goes, I know, to those unique specialists in the boxes at the back of the hall, the simultaneous interpreters.

Dr Spensley has asked me to add that TPI has greatly enjoyed and benefited from the opportunity this Conference provided to meet you all and that they hope their collaboration with many of you will be strengthened as a result of it.

Thank you all, and au revoir.

# List of registered delegates

Mr J. Aagaard
FAO/UNDP
PO Box 1505
Colombo 7
SRI LANKA

Mr D. Adair
Industrial Development Department
Tropical Products Institute
Culham
Abingdon
Oxfordshire OX14 3DB
UK

Mr A. Aga
Fishery and Animal Husbandry Division
Department of Trade
CTC Building
Jakarta
INDONESIA

Mr L. K. Aisi
Department of Primary Industry
Box 2417
Konedobu
PAPUA NEW GUINEA

Dr B. L. Amla
Central Food Technological Research Institute
Mysore 570013
INDIA

Mr A. G. Ardeshir
Department of Life Sciences
Leeds Polytechnic
Calverley Street
Leeds LS1 3HE
UK

Mrs O. A. Aribisala
Nigerian Institute for Oceanography and Marine Research
PMB 12529
Victoria Island
Lagos
FEDERAL REPUBLIC OF NIGERIA

Dr P. T. Arroyo
College of Fisheries
University of the Philippines
Diliman
Quezon City 3004
REPUBLIC OF THE PHILIPPINES

Mr J. F. Arrundale
British Development Division in the Caribbean
Ministry of Overseas Development
PO Box 167
BARBADOS

Mr R. C. Atchison
Van Camp Sea Food Company
11555 Sorrento Valley Road
San Diego
California 92121
USA

Monsieur A. Auffray
Gloria DCS
10 bis Rue des Oliviers
Zone Senia 334
94537 Rungis Cedex
FRANCE

Mr Alhaji Mohammed Augi
Ministry of Agriculture and Natural Resources
PMB 2109
Sokoto
Sokoto State
FEDERAL REPUBLIC OF NIGERIA

Mr N. I. Azeza
Lake Chad Research Institute
PO Box 227
Maiduguri
Bornu State
FEDERAL REPUBLIC OF NIGERIA

Monsieur R. Bardinat
Gloria DCS
10 bis Rue des Oliviers
Zone Senia 334
94527 Rungis Cedex
FRANCE

Mr K. E. Barker
National Fisheries Co Ltd
PO Box 896
Production Avenue
Sea Lots
Port of Spain
TRINIDAD

Mr S. M. Barlow
International Association of Fish Meal Manufacturers
Hoval House
Orchard Parade
Mutton Lane
Potters Bar
Hertfordshire
UK

Mr R. A. Barwani
Ministry of Agriculture, Fisheries, Petroleum and Minerals
Muscat
OMAN

Dr C. Beddows
Department of Life Sciences
Leeds Polytechnic
Calverley Street
Leeds LS1 3HE
UK

Mr N. J. Beraquet
Instituto De Tecnologia de Alimentos
Avenida Brasil 2880
CP 139
13100-Campinas-SP
BRAZIL

Mr T. J. Billy
Fishery Products Inspection and Safety Division
US Department of Commerce/NOAA
National Marine Fisheries Service
Washington DC 20235
USA

Mrs T. Bjergskov
FAO/UNDP
PO Box 1505
Colombo 7
SRI LANKA

Mrs S. Blatchford
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Dr E. G. Bligh
Halifax Laboratory
PO Box 429
Halifax
Nova Scotia B3J 2R3
CANADA

Mrs L. A. Bonsu
Food Research Institute
PO Box M20
Accra
GHANA

Miss N. B. Buban
Bicol University
College of Fisheries
Tabaco
Albay
REPUBLIC OF THE PHILIPPINES

Mr Muzaffer Bumin
General Directorate of Fisheries
Yukselcad No 9
Kizilay
Ankara
TURKEY

Dr G. H. O. Burgess
Torry Research Station
Ministry of Agriculture, Fisheries and Food
PO Box 31
135 Abbey Road
Aberdeen AB9 8DG
UK

Dr J. Burt
Humber Laboratory
Ministry of Agriculture, Fisheries and Food
Wassand Street
Hull
North Humberside HU3 4AR
UK

Mr A. Camacho
Instituto de Pesca
CP 83
Luanda
ANGOLA

Mr D. Cann
Torry Research Station
Ministry of Agriculture, Fisheries and Food
PO Box 31
135 Abbey Road
Aberdeen AB9 8DG
UK

Mr E. Cayetano-Reyes
Direccion de Fomento Co-operativo
Tegucigalpa
REPUBLIC OF HONDURAS

Dr J. C. Caygill
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr G. Clarke
Affish Ltd
Ambassador House
Brigstock Road
Thornton Heath
Surrey CR4 7JG
UK

Mr R. Clarke
Caribbean Development Bank
PO Box 408
Wildey
St Michael
BARBADOS

Dr I. Clayre
L. H. Manderstam and Partners
38 Grosvenor Gardens
London SW1
UK

Mr D. P. M. Clayton
14 Elgin Court
Montpelier
London W5
UK

Mr I. J. Clucas
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr R. C. Cole
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr D. G. Coursey
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr P. Dawson
Canadian International Development Agency
122 Bank Street
Jackson Building
Ottawa
Ontario K1A 0G4
CANADA

Mr J. Day
Kelvin Hughes Aquaculture Services
New North Road
Hainault
Ilford
Essex
UK

Mr G. B. Debling
Department of Science and Food Technology
Grimsby College of Technology
Nun's Corner
Grimsby
South Humberside DN34 5BQ
UK

Mr C. M. Dhatemwa
Fisheries Training Institute
PO Box 124
Entebbe
UGANDA

Lic F. Diaz H.
Direccion General de Desarrollo Regional
Ministry of the Presidency
Avenida Hidalgo No 92
Coyoacan ZP 21
Mexico DF
MEXICO

Mr J. G. Disney
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Dr J. J. Doesburg
Institute for Fishery Products (TNO)
Postbus 183
Ijmuiden
THE NETHERLANDS

Mr W. J. Donaldson
Department of Geography
University of Durham
South Road
Durham City DH1 3LH
UK

Mrs T. Domingo
Aparri College of Fisheries
Aparri
Cagayan 1118
REPUBLIC OF THE PHILIPPINES

Mr J. Drews
Nordischer Maschinenbau
Rud Baader Lübeck
PO Box 1102
Lubeck
FEDERAL REPUBLIC OF GERMANY

Dr I. G. Dunn
Aquatic Biological Consultancy Services Ltd
135 New London Road
Chelmsford
Essex CM2 0QT
UK

Dr H. Durand
Institut Scientifiques et Techniques des Pêches Maritimes
Rue de l'Ile d'Yeu
BP 1049
44037 Nantes Cedex
FRANCE

Mrs A. Enin
Marketing Department
State Fishing Corporation
PO Box 211
Tema
GHANA

Mr A. A. Eyo
Kainji Lake Research Institute
PMB 666
New Bussa
Kwara State
FEDERAL REPUBLIC OF NIGERIA

Mr S. A. M. Fadl
Sudanese Canning and Tomato Paste Industries
PO Box 2554
Khartoum
SUDAN

Monsieur A. J. Faubeau
Fabrique Ivoirienne de Nuoc Mam (FINUMA)
BP 20.874
Abidjan
IVORY COAST

Dr C. Faulhaber
Division of Inspection of Fish and Fishery Products
DIPOA
SCS-Edificio Gilberto Salomão 13°andar
Brasília-DF
BRAZIL

Mr R. N. K. Foo
Sabah Economic Development Corporation
PO Box 2159
Kota Kinabalu
Sabah
MALAYSIA

Mr R. Garm
Fishery Industries Division
FAO
Via delle Terme di Caracalla
00100-Rome
ITALY

Mr W. M. Getaneh
Fisheries Division
Ministry of Agriculture and Forestry
PO Box 1232
Addis Ababa
ETHIOPIA

Mr A. A. Ghaddaf
Public Corporation for Fish Wealth
Steamer Point
Aden
PEOPLES DEMOCRATIC REPUBLIC OF YEMEN

Mr P. Gibson
Marine Fisheries Department
PO Box 260
Port Sudan
SUDAN

Mr E. W. H. Gifford
E. W. H. Gifford and Partners
Carlton House
Ringwood Road
Woodlands
Southampton SO4 2HT
UK

Dr C. Gimenez
Instituto Nacionale de Co-operacion Educativa
Avenida Nva Granada – Edifício INCE – Piso 8
Caracas
REPUBLIC OF VENEZUELA

Mr J. Glucksman
Department of Agriculture, Stock and Fish
Box 2417
Konedobu
PAPUA NEW GUINEA

Mr E. T. A. Golley-Morgan
Fisheries Division
Ministry of Agricultural and Natural Resources
Private Mail Bag
Freetown
REPUBLIC OF SIERRA LEONE

Mr R. M. Gordon
Guyana Agricultural Products Corporation
Agro Industrial Unit
Food Technology Division
30 Industrial Estate
Ruimveldt
Georgetown
GUYANA

Dr B. E. Grimwood
Ministry of Overseas Development
South East Asia Development Division
British Embassy
Bangkok
THAILAND

Lic M. Guadarrama R.
Centro Nacional de Proyectos y Ejecución Pesqueros
Miguel Angel de Quevedo 8-105
Mexico 20 DF
MEXICO

Mr K. M. Hagenbach
Windboats Marine Ltd
Port of Wroxham
Wroxham
Norfolk NR12 8RX
UK

Dr D. N. F. Hall
Ministry of Overseas Development
Eland House
Stag Place
London SW1E 5DH
UK

Mr R. E. Hastings
9 Graham Road
Garstang
Nr Preston
Lancashire
UK

Mr M. Hatfield
Industrial Development Unit
White Fish Authority
St Andrews Dock
Hull
North Humberside HU3 4QE
UK

Mr K. Haywood
Industrial Development Unit
White Fish Authority
St Andrews Dock
Hull
North Humberside HU3 4QE
UK

Mr L. Herborg
Technological Laboratory
Ministry of Fisheries
Building 221
Technical University
2800 Lyngby
DENMARK

Mr A. Herzberg
Fisheries Technology Unit
Department of Fisheries
Ministry of Agriculture
PO Box 699
Haifa 31 000
ISRAEL

Mr P. Hjul
'Fishing News International'
110 Fleet Street
London EC4A 2JL
UK

Mr A. Hoffman
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr K. K. Hooi
Marine Fisheries Research Department
Southeast Asian Fisheries Development Centre
Fisheries Centre
Changi Point
Singapore 17
REPUBLIC OF SINGAPORE

Mr H. H. Huss
Technological Laboratory
Ministry of Fisheries
Building 221
Technical University
2800 Lyngby
DENMARK

Mr S. Ilyas
Research Institute of Fishery Technology
Jalan Karel Satsuit Tubun
Pos Palmerah
Jakarta
INDONESIA

Dr A. K. S. Iman
Ministry of Industry and Agriculture
Doha
QATAR

Mr T. S. G. Iyer
Central Institute of Fisheries Technology
Willingdon Island
Cochin -682003
INDIA

Mr M. B H. Jaafar
Fisheries Department
PO Box 2161
Bandar Seri Begawan
BRUNEI

Mrs G. Jakobsen
Konsumfisk I/S
DK 6700 Esbjerg
DENMARK

Mr A. L. James
Interox Chemicals Ltd
PO Box 8
Kingsway
Luton
Bedfordshire
UK

Mr D. G. James
Fishery Industries Division
FAO
Via delle Terme di Caracalla
00100-Rome
ITALY

Mr R. H. James
Fisheries Division
Ministry of Natural Resources
Honiara
SOLOMON ISLANDS

Mr T. R. W. Jarman
Minster Agriculture
13 Upper High Street
Thame
Oxfordshire
UK

Mr A. B. C. Jones
Fisheries Division
Ministry of Agriculture and Natural Resources
Private Mail Bag
Freetown
REPUBLIC OF SIERRA LEONE

Mr A. H. Jones
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Dr D. T. Jones
Health Department
Corporation of the City of London
PO Box 270
Guildhall
London EC2P 2EJ
UK

Dr N. R. Jones
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr A. Kamari
Agricultural Products Utilization Division
Malaysian Agricultural Research and Development Institute
Box 202
Serdang
Selangor
MALAYSIA

Mr A. H. Kambikambi
Lakes Fisheries of Zambia
PO Box 578
Kitwe
ZAMBIA

Dr Z. Karnicki
Sea Fisheries Institute
Gdynia
PEOPLE'S REPUBLIC OF POLAND

Mr P. N. Karuhanga
East African Freshwater Fisheries Research Organization
East African Community
PO Box 343
Jinja
UGANDA

Miss K. Kelly
Unilever Research Laboratory
Unilever (UK) Ltd
Greyhope Road
Aberdeen AB9 2JA
UK

Mr T. Koloa
Fisheries Division
Agriculture Department
PO Box 14
TONGA

Dr W. Krone
Fishery Industries Division
FAO
Via delle Terme di Caracalla
00100-Rome
ITALY

Dr G. K. Kuriyan
Central Institute of Fisheries Technology
Willingdon Island
Cochin-682003
INDIA

Mr G. D. Lad
Affish Ltd
Ambassador House
Brigstock Road
Thornton Heath
Surrey CR4 7JG
UK

Dr R. M. Lawson
Department of Economics and Commerce
University of Hull
Hull
Northumberside HU6 7RX
UK

Mrs G. L. Lee
Agricultural Products Utilization Division
Malaysian Agricultural Research and Development Institute
Box 202
Serdang
Selangor
MALAYSIA

Mr A. N. Leifer
Altomax
69 Gloucester Place
London W1H 3PH
UK

Dr E. Lessi
Universidade Federal Fluminense
Faculdade de Farmácia
Rua Mario Viana 523
Santa Rosa
Niteroi
ERS
BRAZIL

Dr F. L. Levy
Brian Colquhoun and Partners
23 Upper Grosvenor Street
London W1
UK

Sr F. Liebe T.
FAO
Instituto de Fomento Pesquero (Chile)
Casilla 1287
Santiago
CHILE

Mrs E. Liljeberg
Swedish International Development Authority
S-105,25
Stockholm
SWEDEN

Mr C. H. Lim
Veterinary Public Health Laboratory
Primary Production Department
51 Jalan Buroh
Jurong
Singapore 22
REPUBLIC OF SINGAPORE

Mr C. A. M. Lima dos Santos
Division of Inspection of Fish and Fishery Products
DIPOA
Edificio Gilberto Salomão 13° andar
Brasília-DF
BRAZIL

Mr J. Lisak
Institute of Food Science and Technology
Center for Fish and Economy of the Mediterranean
PO Box 110
FEDERAL PEOPLE'S REPUBLIC OF YUGOSLAVIA

Dr J. Liston
Institute for Food Science and Technology
College of Fisheries
University of Washington
Seattle
Washington 98195
USA

Mr R. D. Long
BP Chemicals Ltd
Devonshire House
Mayfair Place
London W1X 6AY
UK

Mr P. B. Mander
Fisheries Division
Ministry of Natural Resources
Honiara
SOLOMON ISLANDS

Mr A. J. Mathotho
Fisheries Department
Ministry of Agriculture and Natural Resources
PO Box 593
Lilongwe
MALAWI

Sr S. Mattos A.
Laboratorio Tecnologico Del Uruguay (LATU)
Galicia 1133
Montevideo
URUGUAY

Mr G. Meidell-Gerhardsen
Institute of Fisheries Economics
Helleveien 30
5000 Bergen
NORWAY

Miss Z. Merican
Agricultural Products Utilization Division
Malaysian Agricultural Research and Development Institute
Box 202
Serdang
Selangor
MALAYSIA

Mr J. N. Mills
State Fishing Corporation
PO Box 211
Tema
GHANA

Mr I. R. Mkombachepa
Fisheries Division
Ministry of Natural Resources and Tourism
PO Box 2462
Dar-es-Salaam
TANZANIA

Mr A. J. Mkumbae
Tanzania Fisheries Corporation
PO Box 4296
Dar-es-Salaam
TANZANIA

Dr R. A. Moal
SCET International
5–7 Rue Bellini
92806 Puteaux
FRANCE

Mr S. Moini
Iran South Fishery Company
c/o Reading University
Humber Laboratory
Wassand Street
Hull
North Humberside HU3 4AR
UK

Lic M. Morales B.
Apartado Postal No 412
Satelite Edifício de Mexico
MEXICO

Mr K. J. Mughandira
Fisheries Training Centre
Mpwepwe Private Bag
Mangochi
MALAWI

Mrs S. C. Musa
Bicol University
College of Fisheries
Tabaco
Albay
REPUBLIC OF THE PHILIPPINES

Dr J. Nabney
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr G. F. Nanyaro
c/o Institute for Fishery Products (TNO)
Dokweg 37
Ijmuiden
THE NETHERLANDS

Mr Q. L. Ocibo-Lubela
Fisheries Training Institute
PO Box 124
Entebbe
UGANDA

Dr J. Okedi
East African Freshwater Fisheries Research Organization
East African Community
PO Box 343
Jinja
UGANDA

Mr L. C. Okonkwo
Federal Ministry of Industries
PMB 12614
Broad Street
Lagos
FEDERAL REPUBLIC OF NIGERIA

Mr F. Opoka
Frozen Foods (U) Ltd
PO Box 914
Kampala
UGANDA

Mrs N. Osman
Agricultural Products Utilization Division
Malaysian Agricultural Research and Development Institute
Box 202
Serdang
Selangor
MALAYSIA

Dr F. N. C. Osuji
Department of Zoology
Faculty of Science
University of Ibadan
Ibadan
FEDERAL REPUBLIC OF NIGERIA

Mr S. K. Otitiaku
Ghana/IDRC Rural Fishery Research and Development Project
Fisheries Department
Ministry of Agriculture
PO Box 52
Elmina
GHANA

Mr T. S. S. Periris
Department of Fisheries
PO Box 531
Galle Face
Colombo 3
SRI LANKA

Mr F. A. Peterkin
Guyana Food Processors Ltd
McDoom Village
PO Box 236
Greater Georgetown
GUYANA

Dr E. E. Petersen
A/S Atlas
154 Baltorpvej
2750 Ballerup
DENMARK

Miss C. Philbrooks
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr E. Pita
Tuvalu Fisheries Division
Fisheries Department
Funafuti
TUVALU

Dr R. G. Poulter
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr H. Primo
Instituto das Industrias de Pesca de Angola
CP83
Luanda
ANGOLA

Mr D. L. Proctor
Storage Department
Tropical Products Institute
London Road
Slough
Berkshire SL3 7HL
UK

Mr S. Radan
Ingra
41000 Zagreb
Proleterskih brigada 62
FEDERAL PEOPLE'S REPUBLIC OF YUGOSLAVIA

Mr R. Ramos
Cuban Fishing Institute
c/o 10 Conduit Street
London W1
UK

Mr J. F. Rogers
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr T. Rotwitt Schmidt
Niro Atomizer
305 Gladsaxevej
DK 2860 Soeborg
Copenhagen
DENMARK

Mr A. Sabri
Lembaga Kemajuan Ikan Malaysia
Tingkat 4
Bangunan Tambahan KWSP
Petaling Jaya
Selangor
MALAYSIA

Mrs J. Sabri
Faculty of Economics and Administration
University of Malaysia
Pantai Valley
Kuala Lumpur
MALAYSIA

Mr K. Sachithananthan
Fisheries Research Station
PO Box 531
Galle Face
Colombo 3
SRI LANKA

Mr V. O. Sagua
Kainji Lake Research Institute
PMB 666
New Bussa
Kwara State
FEDERAL REPUBLIC OF NIGERIA

Mr S. Sarikaya
General Directorate of Fisheries
Yukselcad No 9
Kizilay
Ankara
TURKEY

Mr M. A. Sattar
Industrial Development Technology Centre
PO Box 2599
Doha
QATAR

Mr L. A. Shah
Caribbean Industrial Research Institute (CARIRI)
Tunapuna PO
Tunapuna
TRINIDAD

Dr J. R. Shaw
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Dr J. Shewan
Torry Research Station
Ministry of Agriculture, Fisheries and Food
PO Box 31
135 Abbey Road
Aberdeen AB9 8DG
UK

Mr G. N. Shimang
Benue Plateau State Government
Ministry of Agriculture
PMB 2050-JOS
Benue Plateau State
FEDERAL REPUBLIC OF NIGERIA

Mr K. Simpson
International Sea Foods Ltd
Cauans Lane
Bridgetown
BARBADOS

Mr B. J. Sivyer
Affish Ltd
Ambassador House
Brigstock Road
Thornton Heath
Surrey CR4 7JG
UK

Mr T. Sorensen
Technological Laboratory
Ministry of Fisheries
Building 221
Technical University
2800 Lyngby
DENMARK

Mr W. Sosrowardoyo
Research Institute of Fishery Technology
Jalan Karel Satsuit Tubun
Pos Palmerah
Jakarta
INDONESIA

Mr O. Sowunmi
Nigerian Stored Products Institute
Federal Ministry of Trade
PMB 5044
Ibadan
FEDERAL REPUBLIC OF NIGERIA

Dr P. C. Spensley
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Dr H. J. Squires
Caribbean Development Bank
PO Box 408
Wildey
St Michael
BARBADOS

Dr M. A. Steinberg
Pacific Utilization Research Center
US Department of Commerce/NOAA
National Marine Fisheries Service
2725 Montlake Boulevard East
Seattle
Washington 98112
USA

Mr J. Stoneman
Ministry of Overseas Development
Eland House
Stag Place
London SW1E 5DH
UK

Mr K. Sundberg
Findus Ltd
CH-1800
Vevey
PO Box 66
SWITZERLAND

Miss P. J. Sutcliffe
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
UK

Mr K. U. Syed
Ministry of Agriculture and Natural Resources
PMB 2109
Sokoto
Sokoto State
FEDERAL REPUBLIC OF NIGERIA

Mr S. O. Talabi
Nigerian Institute for Oceanography and Marine Research
PMB 12529
Victoria Island
Lagos
FEDERAL REPUBLIC OF NIGERIA

Mr I. N. Tatterson
Humber Laboratory
Ministry of Agriculture, Fisheries and Food
Wassand Street
Hull
North Humberside HU3 4AR
UK

Mr A. O. Taylor-Thomas
Fisheries Division
6 Marina Foreshore
Banjul
THE GAMBIA

Mr A. J. Tedder
Fisheries Section
Ministry of Agriculture
PO Box 24
Maseru
LESOTHO

Mr R. W. Thompson
Ministry of Agriculture, Fisheries and Local Government
PO Box N3028
Nassau
BAHAMAS

Mr S. E. Vidot
Ministry of Agriculture, Fisheries and Food
PO Box 54
Victoria
Mahé
SEYCHELLES

Mr N. O. Wade
Fisheries Unit
Ministry of Trade, Industry, Co-operatives and Consumer Protection
Belize City
BELIZE

Mr J. D. Walton
International Fish Co Ltd
14 West Smithfield
London EC1A 9JP
UK

Mr J. J. Waterman
Torry Research Station
Ministry of Agriculture, Fisheries and Food
PO Box 31
135 Abbey Road
Aberdeen AB9 8DG
UK

Mr G. R. Watkin
Fishmongers Company
Fishmongers Hall
London EC4R 9EL
UK

Mr C. E. P. Watson
White Fish Authority
Sea Fisheries House
10 Young Street
Edinburgh EH2 4JQ
UK

Mr P. K. Watson
Atalanta (UK) Limited
Imperial House
Dominion Street
London EC2M 2SA
UK

Mr R. Westra
FAO/SIDA
PO Box 1505
Colombo 7
SRI LANKA

Mr W. A. Wilkinson
Department of Agriculture
PO Box 14
Nuru'Alofa
TONGA

Mr J. Wilson
Fisheries Department
Ministry of Agriculture and Natural Resources
PO Box 593
Lilongwe
MALAWI

Mr C. W. Yap
Fisheries Division
Ministry of Agriculture
Swettenham Road
Kuala Lumpur 10-02
MALAYSIA

Mr N. W. Young
Young's Seafoods Ltd
Mountbarrow House
Elizabeth Street
London SW1 9RE
UK

Mrs A. Zain
Department of Food Science and Technology
University of Agriculture
Serdang
Selangor
MALAYSIA

Mr T. Zallie
Namiasi Fish Landing
PO Box 53
Mangochi
MALAWI

Sr F. Zapata L.
Productos Pesqueros Mexicanos SA de CV
Avenida Baja California No 255
Edificio A 3er Piso
Colonia Hipodromo Conelesa ZP11
MEXICO

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